6

Globalization of Innovation

Since the Nobel Prize–winning work of Robert Solow (1957), innovation has been viewed as the cornerstone of economic growth. How is research and development (R&D) related to innovation, and does the type or source of R&D affect the innovative process and thereby growth? The foundations of innovation are research dollars, research scientists, and a policy-supported research system of industry, people, and academic institutions. But the composition of the mix (and of the policies) is not fully known and certainly is not static. Moreover, the lesson from examining IT is that innovations applied to market needs outside the narrow confines of the innovating sector matter a lot for overall productivity and growth; that is, the "D" in R&D—the practical application of research findings to market needs—is crucial and complex. Finally, linking innovation to growth requires having educated customers (consumers and businesses) to demand the output of R&D, a financial sector that is willing to take risks on new ideas, a business climate and managers desirous of using new methods, and workers able to complement the innovations in the workplace. Given the complexity of these linkages, it is not surprising that academic analysis of the relationship between R&D, innovation, and growth is voluminous and mixed in its findings.

An important lens of focus is to gauge and balance the gains to the United States from cheaper innovations obtained through foreign sourcing of science and engineering talent that may lead to even more US productivity growth (through the channels already discussed) against the potential threat of losing the technological edge that could come from innovating only at home. Being the technology leader confers economic gains to the extent that technology is protected by intellectual property law and so yields first-mover revenue gains. But, more generally, failing to retain research talent and development facilities may imply a loss of innovation

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tailored to domestic needs and local demand. This can have long-term consequences to the extent that innovation responsive to domestic needs is a particularly catalytic source of productivity growth.

This chapter reviews several aspects of the data and academic analysis on the potential implications of a more globalized R&D function, with particular reference to R&D activities in the IT sector. With the globalization process of R&D having just begun, implications must remain speculative.

R&D, Innovation, and Growth

Looking at R&D in the context of the domestic National Income and Product Accounts (NIPA) is one approach to evaluating the importance of R&D in general and the IT sector in particular. In the standard presentation of NIPA, R&D is expensed rather than capitalized as an investment. If it were instead treated akin to software, as investment, then R&D appears to play an important role in productivity performance and US economic growth—perhaps accounting for between 5 and 9 percent of growth in GDP over 1996–2000 and between 3 and 10 percent of GDP over 1961–2000. The upper range of importance is derived from the importance of R&D spillover effects; that is, R&D appears to have a particularly high rate of return, indicative of its ancillary effects beyond the sector in which it is invested.[1]

In the academic analysis, the relationship between trend productivity growth and innovation as measured by domestic R&D variables such as patents, expenditures, and researchers has a long history. Despite the logical relationship whereby R&D spending should increase measures of innovation (patents and citations) and thereby increase productivity, finding these positive correlations has been challenging. This has been disappointing to policymakers who see research funding as a sure-fire way to enhance growth.

The more recent research that links globalization, R&D, and growth points to a possible answer as to why the logical relationship is not necessarily evidenced in the data. Dollars spent on research tend to spur productivity growth only when the environment is open and competition is strong. For example, R&D expenditures in sectors that are protected from global competition do not translate into higher labor productivity in those sectors, whereas R&D expenditures in sectors facing global competition do enhance productivity both for high- and low-technology types of products (Baygan and Mann 1999).

Other research points to ways a country can obtain growth-enhancing technological innovations beyond its own research undertakings. Two ways

1. See Fraumeni and Okubo (2005) for a detailed discussion of the accounting methodology and a possible R&D "satellite" account for the NIPA.

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that globalization enhances the relationship between R&D and growth are trade in imported intermediate products that embody innovation and direct investment that may fund and transmit innovation (Coe and Helpman 1995; Bayoumi, Coe, and Helpman 1996; Eaton and Kortum 1996; Keller 2001a and 2001b; Lee and Wan 2001). Analysis shows that countries with greater exposure to trade, particularly imports of capital goods, intermediates, and R&D-intensive products, enjoy greater technology spillovers. The results are particularly strong for smaller countries and those farther away from the technological frontier.

The United States is big and at the technology frontier, so do the benefits of foreign R&D, foreign investment in the US economy, and imports of technology-intensive products hold for the United States? The answer is yes. Inward foreign direct investment (FDI) (as measured by the detailed activity of workers in the affiliates of foreign multinationals in the United States) is a quantitatively important source of US productivity growth. Research finds that US productivity growth is about 30 percent higher in industry sectors where there is inward FDI and high R&D intensity, suggesting positive spillovers between global and domestic technological innovation. Perhaps 14 percent of the increase in productivity growth in the manufacturing sectors between 1987 and 1996 came from inward FDI (Keller and Yeaple 2002).

International spillovers have their greatest impact on domestic productivity when domestic competition works to ensure that innovations are taken up by firms. Research on innovation usually focuses on stimulating innovation and protecting it via property-rights laws. Yet, much of the benefit of international spillovers depends on the ability to generate similar kinds of products on one's own (i.e., to "imitate") (Haskel, Pereira, and Slaughter 2002; Griffith, Redding, and Van Reenan 2000). Robust product-market competition, entry and exit of firms, and responsive labor markets are key to allowing domestic firms to both innovate and imitate other countries' and firms' innovations.

Can IT itself (abstracting from the globalization of IT) affect these linkages and R&D spillovers? IT increases the tradability of ideas and cross-border transfer of innovations, both through communications networks and because IT increases the ability of firms to engage in global production. Moreover, IT increases the tradability of many services that are part of the overall package of IT innovations. Hence, IT is an enabling technology that has its preponderant impact via the new and cheaper ways it allows existing occupations, products, and activities to be organized, produced, and delivered. So globalized IT most likely does enhance R&D spillovers, both into the United States and abroad.

Despite this broad evidence of the importance of global two-way spillovers associated with trade in technologically advanced products, there is a nagging concern that the United States is falling behind international competitors in research intensity or output. Moreover, some question

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whether the spillover benefits of globalization extend to the research function itself. Instead, globalized R&D may hamper US innovation or hand technological leadership to countries where US firms engage in R&D. One difficulty in assessing the issue is measurement of innovation inputs and outputs.

Information Technology R&D: Who, How Much, and Where?

As was discussed earlier in the context of IT hardware and communications, technological innovation in IT products has been perhaps the most important source of economic gain in the United States over the past decade. Globalization plays an important supporting role, but technological change is key to the price reductions that are so important in driving the growth and diffusion of IT investment and the concomitant acceleration in productivity growth. Thus there is some concern about anecdotes that imply that US IT firms are not just globalizing production and sales but increasingly are globalizing their innovative (R&D) activities. Will the innovation gains accrue to the country in which the innovating actually takes place? And, therefore, will US innovation slacken if R&D is fragmented abroad like so many other activities? Data on R&D workers and funding do confirm that IT is a research-intensive activity, as compared with other sectors of the US economy. The available intrafirm data do not confirm anecdotes that R&D is being fragmented, but some other indicators, available on a more timely basis, do confirm such fragmentation, although implications of this fragmentation are unclear.

Measuring Research Intensity

What are the characteristics of R&D for US industry overall, in the IT sector in particular, and for US-located firms versus affiliates abroad of US-owned firms? If the research intensity of US firms is declining, or if US parent firms are doing more research abroad in their affiliates rather than at home, this trend should manifest itself in declining research intensity of firms in the US economy.

Research intensity can be measured in a number of ways, such as scientists and engineers as a share of total employees, research spending per research employee, or research spending as a share of sales. Several features of the data are worth considering: the change in research intensity over time, the difference in research intensity across different industry sectors, and differences in research intensity of different parts of a multinational enterprise. By almost all of these metrics, the data suggest a rising research intensity for the US economy overall, a much higher and ris-

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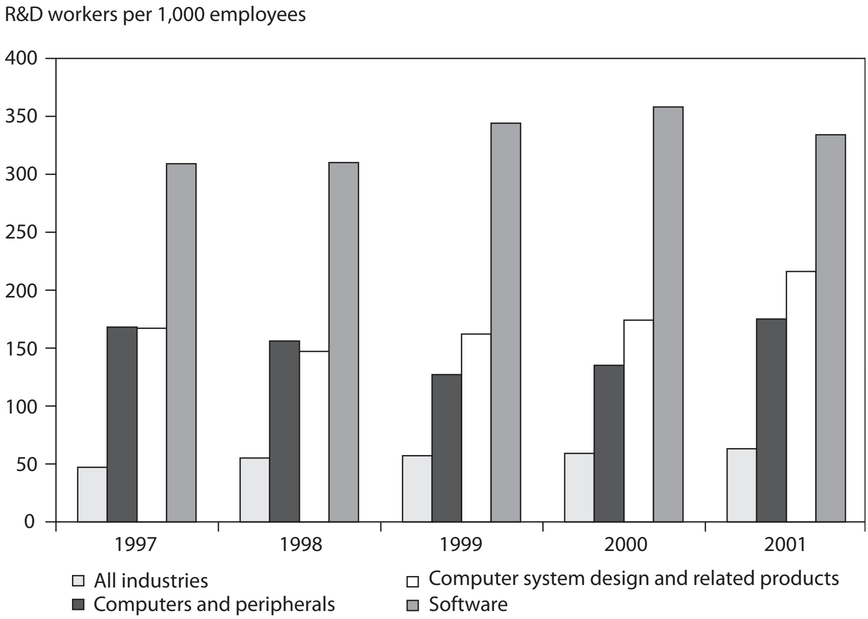
Figure 6.1 R&D intensity: R&D workers, 1997–2001



Sources: Bureau of Economic Analysis, US Direct Investment Abroad: Financial and Operating Data for US Multinational Companies, www.bea.gov (accessed September 30, 2005), and Foreign Direct Investment in the US: Financial and Operating Data for US Affiliates of Foreign Multinational Companies, www.bea.gov (accessed September 30, 2005).

ing research intensity in the IT sectors, and a dramatically lower research intensity at US affiliates abroad compared with their parents in the United States. But most of these data are badly out of date, ending in 2001 or 2003, for such a dynamic activity and for the IT sector characterized by globalization and technological change. Both more timely data and more research to match and analyze the data are needed. Nevertheless, these data are useful to review.

First, consider the level and change in research intensity over time across the whole of the US economy and selected IT sectors (figure 6.1). Research intensity measured by scientists and engineers (research employees) as a share of total employment at the firm addresses how research worker–intensive technologically advanced sectors might be. R&D employment as a share of total employment has risen modestly for the whole economy. One reason for this economy-wide increase is the rising share of IT, which has a much higher research worker intensity. The computer and electronics products sector has 2.8 times more research workers than the economy overall, while software has 5.3 times more.

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Table 6.1 R&D spending per full-time equivalent R&D scientist or engineer, 1999–2001

Industry	1999	2000	2001
All industries	179,990	192,322	189,918
Computer and electronic products[a]	172,294	207,637	187,265
Computers and peripheral equipment[b]	(D)	232,125	(D)
Software	153,635	158,554	159,568
Computer system design and related products	(D)	124,254	167,606

(D) = Data suppressed by the BEA for confidentiality reasons.

a. Imputation of more than 50 percent.
b. No imputation.

Source: National Science Foundation Research and Development in Industry statistics, table A39, table A34, and table A38 for 1999, 2000, 2001, respectively.

In the IT sector, research worker intensity is shifting from IT hardware to IT software and services, consistent with the pattern of production and demand already observed. In the software sector, the modest drop in 2001 in research worker intensity is consistent with the bust of the technology bubble, although the offshoring of some software research jobs is also a possibility. The occupation data presented in chapter 5 revealed job losses in only one category of technology professional—programmers—whereas other research-oriented job categories saw job gains.

A second metric addresses how financially intensive the innovation process might be (table 6.1). The very short time series of data reveals mostly that firms producing IT hardware spend more research dollars per worker than firms in software and computer system design, which are more research worker intensive. This matches the relatively more capital-intensive nature of production of manufactured products. Because research spending per worker intensity is about the same for IT firms as for all industries, it appears that the number of R&D workers is the key driver of the higher research intensity of the IT sector. So as IT producers (particularly of services and software) expand as a share of the US economy, the much higher research worker intensity of these sectors should raise the economy-wide average. These data imply that research workers, and their education and skills, are critical to the IT innovative process, particularly as firms move into services and software.

Analysis more specifically focused on the role of globalization in research is revealed in the data for IT multinationals (table 6.2). The difference in research intensity across the form of incorporation of the firm gives important insight into the question of the globalization of R&D. First, as with the other metrics of research intensity, the IT sector's research intensity is much

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Table 6.2 Research intensity in multinational firms, 1999 and 2003 (R&D cents per dollar of sales)

	Multinational affiliates						
	US parent		Affiliate in United States with foreign parent		US affiliate abroad with US parent		US affiliate abroad: R&D funded by affiliate 1999[a]
Industry	**1999**	**2003**	**1999**	**2003**	**1999**	**2003**	
All industries (2001)	2.11	2.12	1.34	1.38	0.82	0.77	1.24
Computer and electronic products	8.91	10.79	4.81	5.57	1.70	1.44	1.03
Information and data processing services	(D)	2.68	(D)	(D)	0.27	0.26	(D)
Computer systems design and related services	8.39	10.86	5.58	3.06	0.78	0.96	2.13

(D) = Data suppressed by the BEA for confidentiality reasons.

a. Measured as R&D dollars performed at affiliates/R&D funded by affiliate.

Sources: Bureau of Economic Analysis, US Direct Investment Abroad: Financial and Operating Data for US Multinational Companies, www.bea.gov (accessed September 30, 2005), and Foreign Direct Investment in the US: Financial and Operating Data for US Affiliates of Foreign Multinational Companies, www.bea.gov (accessed September 30, 2005).

higher than that for all industries, and has increased over the short time period of the sample. In terms of research spending as a share of sales, research intensity is very similar comparing IT hardware and IT services (although data processing services has a much lower research spending intensity). This suggests that firms are willing to spend the same amount on new product development for IT hardware as for IT services.

With respect to research by globalized affiliates of a multinational firm, the US parent is vastly more research spending–intensive than its own foreign subsidiaries. For example, in 2003 the "computer and electronic products" parent spent about 11 cents on R&D for each $1 of sales but only spent about 1½ cents or even less on R&D at its foreign affiliates. These data also reveal that the research spending intensity of US-located affiliates of foreign parents is about half that of the US IT parent. Together, these data show that research spending intensity is much higher in the United States and suggest that very little of the R&D dollar is being spent abroad. However, the data lag the most recent innovations in cross-border communications and fragmentation and digitization of services. More current data would improve the analysis of where research spending is being undertaken.

Finally, the 1999 benchmark data show how much of the research being undertaken at the affiliate is funded by and spent at that affiliate. Overall in the industry, the R&D spending at the affiliate is funded by that affiliate with some additional contribution from the parent (1.24). Within the IT sector, in IT hardware, the affiliates' R&D activities are self-funded (1.03), whereas for software and services, it appears that the affiliate gets substantial funds (about double its own funding) from the parent to perform R&D (2.13). Whether the parent would have funded more of its own research at home is unclear. It may be that the parent was funding research at the affiliate that ultimately was destined for the parent's market, not the affiliate's market; or, particularly for IT services, the opposite could well be the case given the high share of affiliate sales that are destined for the local market.

Finally, mandatory business surveys of all US multinationals imply that R&D spending by the IT sector continues to be concentrated in the United States (figure 6.2). Among US-owned IT firms, about 95 percent of global R&D expenditure was spent in the United States in 2002, amounting to about $30 billion (hardware and services).[2] Foreign-owned IT hardware firms located in the United States (as discussed in chapter 2) are three times more R&D intensive than are US firms located abroad; these firms added about $2 billion to US-located R&D activities in the IT sector in 2002. Expenditure data are corroborated by benchmark data from 1999 on the share of US-located employment in the R&D activity, at 92 percent.

2. Table 6.2 suggests that the parent funds R&D that is performed by the affiliate, particularly IT services. Discussions with industry confirm this activity. Hence the data in figure 6.2 may overstate the spending by multinationals in the United States.

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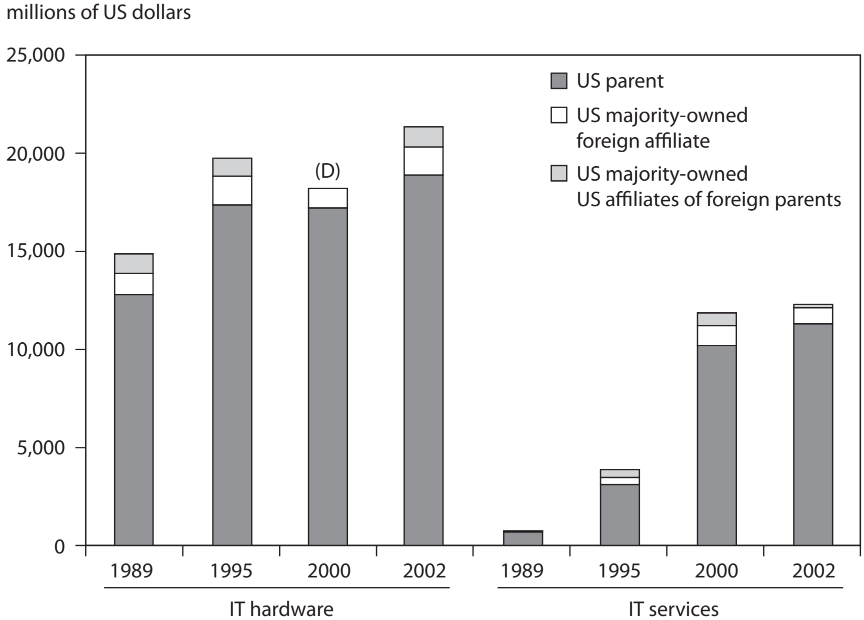
Figure 6.2 Global R&D expenditure by US IT hardware and services firms, by industry of parent, selected years



(D) = Data suppressed by the BEA for confidentiality reasons.

Sources: Bureau of Economic Analysis, US Direct Investment Abroad: Financial and Operating Data for US Multinational Companies, www.bea.gov (accessed September 30, 2005), and Foreign Direct Investment in the US: Financial and Operating Data for US Affiliates of Foreign Multinational Companies, www.bea.gov (accessed September 30, 2005).

Consistent with the trend from IT hardware to services, the share that US IT firms spent on R&D for IT services increased from 5 percent of R&D expenditure in 1989 to 37 percent in 2002. The next detailed benchmark data for 2004 (to be released in 2007) for US and foreign multinationals will be key for tracking the role that it and communications infrastructure play in fragmenting and globalizing R&D.

Another approach to gaining information regarding firms' global R&D strategies is through surveys of companies. A narrow survey of California-based IT manufacturing firms reveals that R&D activities are outsourced—but more often to other domestic locations, rather than offshore. In addition, most of the outsourced R&D is within a corporate entity, consistent with most models where intellectual property is best protected within the corporate ownership structure. Finally, the survey responses reveal that the more innovative and cutting-edge the research, the more likely it is to remain within the core firm (Bardhan and Jaffee 2005).

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Patents and R&D

Corporate data confirm that IT is a research-intensive activity led by the US private sector. Available data for individual firms in the global marketplace show that 32 of the top 50 global IT and communications companies that focused on the IT subsector (that is, excluding telecommunications carriers) spent a combined $73 billion on R&D expenditure in 2002. This is more than triple the R&D expenditures by the US government ($24 billion) that year and surpasses the combined expenditure of the Organization for Economic Cooperation and Development (OECD) countries ($65 billion).[3] Within the United States, R&D expenditure by US IT hardware firms accounted for about 38 percent of R&D by the manufacturing sector in 2000, up from about 32 percent in 1990 (OECD 2002b, 27; OECD 2004c).

Some measures of innovation present a more mixed picture of US innovation and potential. One measure of R&D output is patents registered by the US Patent and Trademark Office (PTO). Patents rose during the last two decades, with a particularly dramatic increase since 1998 (figures 6.3a and 6.3b) due in large part to a particular kind of IT patent—the so-called business method patent—that is somewhat controversial (Mann 2001). The US share of US PTO patents to US-located first-named inventors has remained relatively stable, although with a bit of a decline in recent years.

A look at the corporate identities of the patenting organizations implies that despite the change in the average US position, individual US firms continue to lead patenting and that IT firms are increasingly represented in the top ranks of patenting firms. First, US-headquartered corporations represent 23 of the top 50 and 45 of the top 100 organizations ranked by number of patents filed between 1995 and 2004. The next nationality represented is Japan, with 17 and 33 companies represented in the top 50 and top 100, respectively. No other country comes close, nor even does Europe as a group (figure 6.4).[4]

On the other hand, consider how the patent-weighted share of the United States changes over time (figure 6.4). Prior to 1995, the US patent lead was extreme, with more than 55 percent of patents granted to US firms. In comparison, the 1995–2001 period shows a drop in the share of patents granted to US firms and a rise in those to Japanese firms. However, during 1995–2004, the US lead stabilized. From 1995 to 2001, the US share of all patents was 43 percent, whereas it was 40 percent for Japan. From 2002 to 2004, the US share rose just slightly to 44 percent, but the

3. US and OECD government R&D data are from the OECD (2004c), as noted in "#52 Government Intramural Expenditure on R&D." Government expenditures in the OECD database are calculated in current purchasing power parity (PPP) dollars. Adjusting the current dollar expenditure for the OECD from PPP terms to current exchange rates yields $65 billion in current US dollars.

4. Examining patent data from the standpoint of the European Patent and Trademark Office may yield a somewhat less skewed picture.

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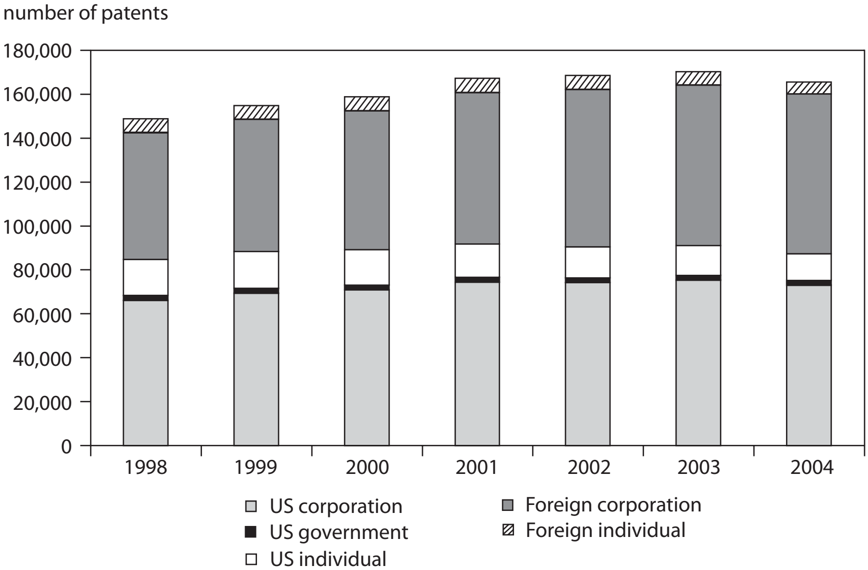
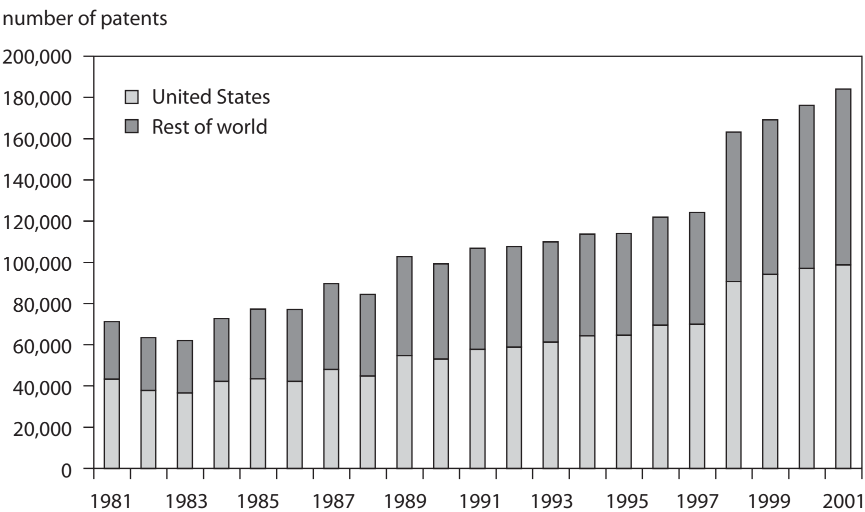
Figure 6.3a Patents granted by US Patent and Trademark Office, by residence of first-named inventor and ownership category, 1998–2004



Note: The data for foreign governments are too small to be shown in the figure.

Figure 6.3b Patents granted by US Patent and Trademark Office, by residence of first-named inventor, 1981–2001



Source: US Patent and Trademark Office.

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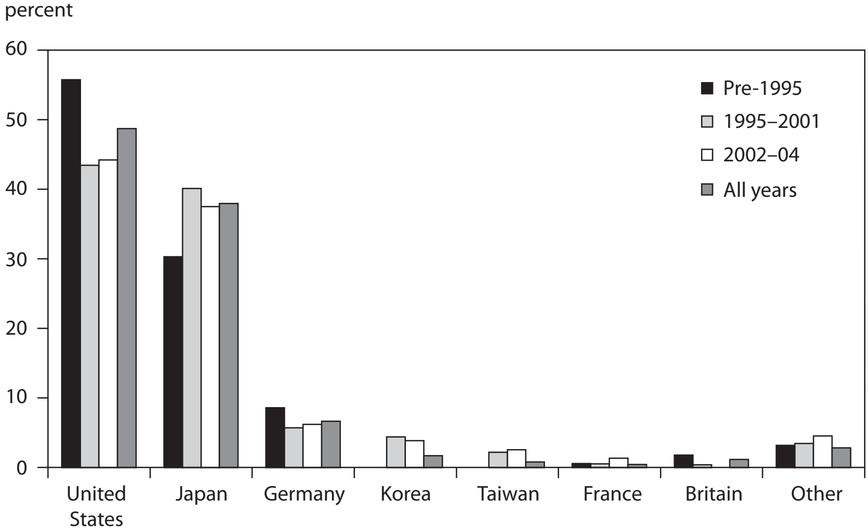
Figure 6.4 Share of patents granted to top 100 companies, selected periods



Note: The top 100 are drawn from the total number of companies that have ever been granted more than 1,000 patents by the US Patent and Trademark Office.

Source: US Patent and Trademark Office.

Japanese share fell to 37 percent. Thus, from 1960 to 2004, the US dominance in patenting fell. But in recent years, the US share has ticked upward again. Other countries do not play a big role, although the share of patents granted to "other countries" has risen to 5 percent for the last two years of the sample, from about 3 percent in previous time periods.

A perusal of the corporate identities over time shows that the leading patenting corporations are all multinational household names, and increasingly they are IT names (although only four are US IT names). The top 10 firms granted patents for 2004 were IBM, Matsushita, Canon, Hewlett-Packard, Micron, Samsung, Intel, Hitachi, Sony, and Toshiba. A look at the lifetime of patents awarded suggests a fair degree of stasis more than a change in the ranks. The top 10 lifetime patenting firms are IBM, Canon, Hitachi, General Electric, Toshiba, NEC, Matsushita, Mitsubishi, Sony, and Motorola.

Examining the details of the corporate identity data over time, however, reveals that US IT firms have been moving up the ranks in numbers of patents granted (tables 6.3). For example, Micron Technologies was ranked 248th in total patents granted prior to 1991. But its rank was 130th in 1991 and 166th in 1995, and then it vaulted to seventh in 2000 and fifth in 2004. Intel was ranked 271st by total patents granted prior to 1991, then steadily moved up the ranks to 57th in 1991, 34th in 1995, 18th in 2000,

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Table 6.3 Rank of company by number of patents granted by year, selected years

Company	Total pre-1991	1991	1995	2000	2004
IBM	3	8	1	1	1
Hewlett-Packard	77	32	19	15	4
Micron Technologies	248	130	166	7	5
Intel	217	57	34	18	7
Microsoft	261	259	188	43	26

Note: Companies ranked must have been granted at least 1,000 patents to be included in the list.

Source: US Patent and Trademark Office.

and seventh in 2005. Microsoft was ranked 261st by total patents granted prior to 1991, then steadily moved up the ranks to 26th by 2004. IBM leads for most of the 1990s, and recovered from the challenges of its restructuring (discussed in box 2.2) to regain the top spot.

The patenting data reveal the companies that were granted the patents, but not where the research was undertaken. Publicly available data from six large US-based IT firms suggest a more globalized picture of R&D activity, with research facilities located around the world (table 6.4). How important these R&D facilities in foreign countries are for innovation in the industry is not clear. IT firms may engage in R&D abroad for a number of active and passive reasons. A passive reason is to purchase a foreign firm that has significant R&D activity and technologies pertinent to the firm's US and global business strategy (box 6.1). An example of a more active strategy is that of Intel. Since 1990, Intel Capital has invested in more than 1,000 IT companies in some 30 countries, with its 2003 investments ($700 million) in 120 companies, of which 40 percent were located outside the United States (Intel Corporation 2004, 8). Yet a third rationale for global R&D is that bringing together scientists with different academic training raises overall creativity, and speeds a product to market, as box 6.2 shows in the case of the iPod. There may be more R&D activity being undertaken abroad than is suggested by the research worker and R&D expenditure data, but there is no clear implication of the effect of that activity on US innovation or technological leadership.

All told, specific examples indicate that research is now more global, and the specific examples and survey results suggest that there are gains to this globalization. At the same time, the data do not point to a reduction in the R&D intensity of US IT firms, and surveys confirm that innovation within the firm remains key, although parent firms do spend R&D dollars at their affiliates. US IT companies are patenting at an increasing rate, and are amply represented in the top ranks of firms that patent. These data suggest a lively environment of innovation is being maintained in the United States and by US IT firms in their global operations.

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Table 6.4 R&D facility locations abroad for US companies ranked among the top 50 global IT and communications firms[a]

Company	Location	Number of employees
IBM	Haifa, Israel	490
	Zurich, Switzerland	250
	Tokyo, Japan	188
	Beijing, China	150
	Delhi, India	110
Hewlett-Packard	Bristol, United Kingdom	n.a.
	Haifa, Israel	16
	Tokyo, Japan	20
	Bangalore, India	14
Intel	China	n.a.
	India	n.a.
	Israel	n.a.
	Malaysia	n.a.
	Philippines	n.a.
	Russia	n.a.
Motorola	Shanghai, China	n.a.
	Tianjin, China	n.a.
	India	n.a.
	Paris, France	n.a.
	Basingstoke, United Kingdom	n.a.
	Wiesbaden, Germany	n.a.
EMC	Belgium	n.a.
	India	n.a.
	Cork, Ireland	n.a.
Dell	China (design)	n.a.
	Taiwan (design)	n.a.
Microsoft	Beijing, China	n.a.
	Dublin, Ireland	n.a.
	Vedbaek, Denmark	n.a.
	Hyderabad, India	n.a.
	Haifa, Israel	n.a.
	Cambridge, United Kingdom	n.a.
Xerox	France	n.a.
	United Kingdom	n.a.
	Canada	n.a.
3M	None	
Cisco	None	
Emerson	n.a.	

n.a. = not available

a. Excluding telecommunications services.

Sources: Company Web sites and 2003 and 2004 10-K filings.

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Box 6.1 See it, like it, buy it: Purchasing foreign innovations

The US information technology industry has created some of the most innovative institutions in the world in the Hewlett-Packard (HP) Palo Alto or IBM Thomas J. Watson research labs. Yet not all innovations that firms might desire come from "blue sky" laboratories. US IT companies increasingly seek access to cutting-edge technology via strategic partnerships through outright purchases of R&D-intensive start-ups located both inside and, increasingly, outside the United States. When the parent company possesses sophisticated global marketing and distribution networks, its acquired new technology ramps up quickly into higher value-added product categories, and the value of intellectual property is leveraged via sales to all the major global markets.

For example, in September 2001, HP purchased the Dutch industrial printing company Indigo N.V. The transaction was aimed at promoting HP's image and printing businesses by obtaining Indigo's state-of-the-art Digital Offset Color™ technology. The purchase followed a three-year alliance between the two companies, during which time HP had injected a $100 million equity investment into Indigo and had become the global original equipment manufacturer (OEM) distributor of particular Indigo products.

At the time of acquisition, Indigo N.V. was among the technological leaders in its field, with more than 20 percent of its workforce and 12 percent of total revenues dedicated to R&D. In addition, Indigo received about 3 percent of its total revenues in R&D grants from the Israeli government, which hosted many of the company's facilities. However, Indigo was critically dependent on the continued success of its principal printing technology and had never had a profitable full fiscal year. It continued to finance itself through outside capital injections and short-term bank loans. The company increasingly was forced to rely on strategic marketing and distribution relationships with third parties to continue to grow its business, which was already dispersed, with offices in eight countries and customers in more than 40 countries.

HP's purchase was advantageous for both companies: HP got access to a high value-added new technology—partially developed through the support of a foreign government—that it could now sell globally. Indigo was relieved of its problems of financing continued growth, distribution problems, and its mono-technological risk. The globalizing business environment in the IT industry provides for increased competition as well as new opportunities, regardless of company size.

As will be discussed in the next section, however, the future pipeline of researchers may be stressed, and, recalling the data from table 6.1, the work of these researchers is crucial to R&D in IT.

Concerns remain over the globalization of R&D because it is the foundation for innovation, and therefore an important ingredient in productivity

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Box 6.2 The Apple iPod: Globalization of R&D and the small firm

Most people will have seen it—the sleek-looking gadget with the white plug earphones. The phenomenal success of the Apple iPod portable music player neatly illustrates several aspects of globalization of the IT industry.

First, the iPod conveys novel benefits that are next to impossible to include in statistical GDP estimates. You can take it on a jog without fearing that shaking it will scratch your favorite music (i.e., compact disc); it holds thousands of songs, so you no longer need to bring with you scores of cassette tapes for the Walkman; you can tailor-make your own prolonged play list and do not have to purchase entire albums to get a particular song you like; and, of course, the iPod interface is ergonomically and intuitively designed. Such benefits that consumers derive from new technological innovations are almost never included in GDP estimates. This is just a small example of how the gains from particularly innovative products or transactions, such as IT, frequently are underestimated by standards statistics.

Equally important, though, is that the iPod illustrates just how globalization of the IT industry brings these benefits to consumers rapidly and at an attractive price. The iPod, despite being sold by Apple, is not 100 percent "American as apple pie": whereas the iPod is an example of the California-based firm's core strengths of innovative "cool" design and user-friendly high-tech interfaces, its components come from companies all over the world.

Look inside the iPod. There is a hard drive from the Japanese company Hitachi, a battery from Sony (also Japanese), a controller semiconductor chip from California-based PortalPlayer Inc., a stereo digital-to-analog converter from Wolfson Microelectronics in Edinburgh, UK, a flash memory chip from Sharp Electronics (Japan), an interface controller from US-based Texas Instruments, and a power management and battery charger from Linear Technologies in California. More recent iPod generations also include power management chips from Dutch Royal Philips Electronics, Korean DRAM from Samsung Electronics, USB interface chips from Cypress Semiconductors in San Jose, California, switching

(box continues next page)

growth. If R&D is globalized, does that lessen its potency in raising productivity growth in the United States? Or does purchased foreign R&D or the immigration of research scientists enable the United States to maintain overall innovative superiority? The previous chapter concluded decisively that innovation that interacts with the marketplace of workers and firms is critically important to generating the greatest value to society that innovation

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Box 6.2 *(continued)*

regulator controls from National Semiconductor Corp. in Santa Clara, California, and control support from International Rectifier in El Segundo, California, and Synaptics, Inc. in San Jose.[1]

The globalization of the iPod does not stop with the big companies or with the tangible inside pieces. It is also a result of globalized R&D. That established global giants in the IT industry such as Hitachi, Sony, Sharp, Texas Instruments, Philips, or Samsung have a global presence is not a surprise. But much smaller companies involved in the iPod also deserve the label "global company." For instance, Cypress Semiconductors from San Jose, in addition to nine US-located design centers, has R&D facilities in Moscow, Bangalore (India), Hyderabad (India), Cork (Ireland), Istanbul, and Mechelen (Belgium), while maintaining three US production facilities and one in the Philippines.[2] Similarly, National Semiconductor Corp. from Santa Clara has 15 US design centers, as well as in the Netherlands (2), Germany, Scotland, Finland (2), India, China (2), Taiwan, South Korea, and Japan, while maintaining production facilities in the United States (2), Scotland, Malaysia, Singapore, and China.[3] Smaller non-US IT companies, such as the UK's Wolfson Microelectronics, also have a distinctly global profile, with production outsourced to South Korea, China, and Singapore, while carrying out product testing in Malaysia and the UK.[4]

So while it is conceivable that the iPod may have been invented in a nonglobalized world, it certainly would not have come to market in 2001 for only a few hundred dollars.

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1. All information is from "Inside the Apple iPod Design Triumph," *Electronic Design Chain* magazine, summer 2002, and John H. Day, "Inside iPod," Electronic Design Online, January 20, 2005, http://elecdesign.com (accessed June 15, 2005).
2. See the company's Web site at www.cypress.com (accessed June 15, 2005).
3. See the company's Web site at www.national.com (accessed June 15, 2005).
4. See Wolfson Microelectronics Annual Report 2004, www.wolfsonmicro.com (accessed June 15, 2005).

can offer. Hence, almost without regard to the location of the R&D, the key to continued US productivity growth is to maintain the environment that is conducive to developing as well as using those innovations and allowing the transformation of business to take advantage of them, even when generated abroad. A key ingredient to this success is the people who are part of innovation and transformation, and here the challenges appear more daunting.

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R&D in the US Balance of Payments

One area where the nationality of R&D does matter is in the macroeconomic measures of the US trade balance. Research and development outputs, once they receive a patent, copyright, or other forms of intellectual property protection, generate a stream of license or royalty fees from the user. These streams are reflected in the US balance of payments as receipts (inflows of fees from users of US intellectual property outside the United States) and payments (outflows of fees from users located in the United States to foreign owners of intellectual property). US technological leadership and ownership of intellectual property yielded a net positive stream of royalties and license fees of some $32 billion in 2004, against the projected negative current account figure of about $635 billion for that year.

Much of this international trade in intellectual property, such as royalties, is intrafirm trade, with about 80 percent of intellectual property imports and 70 percent of exports between affiliated parties. On the export side, virtually all of the flows are receipts to the US parent for use of intellectual property by majority-owned foreign affiliates abroad. On the import side, virtually all of the flows are payments to the foreign parent from US-located, majority-owned US affiliates of foreign parents.

The intellectual property trade surplus has continued to rise. US receipts for intellectual property rose eightfold from about $4 billion in 1982 to $33.3 billion in 2004 (manufacturing and services). In contrast, payments for intellectual property were essentially zero until the mid-1990s, and crept up to about $2.8 billion in 2004. The bulk of the increase in intellectual property receipts comes from rising net intellectual property in services, whereas net intellectual property receipts for manufacturing has only recently started to grow after stagnating at the turn of the century (figure 6.5).

Is the slower growth of intellectual property in manufacturing due to a movement abroad of manufacturing R&D to the affiliated operation (with the associated return flow of licensing payments)? The data on research intensity for "all industries" and "computer and electronic products" (e.g., IT hardware) presented in table 6.2 show that research expenditure per sales dollar rose at home and fell at the affiliate location. The research intensity of the US affiliate of the foreign multinational also rose, and intellectual property payments back to the parent raised imports. But, it does not appear from these data that manufacturing intellectual property moved abroad with the manufacturing facilities. The data in figure 6.5 essentially are another manifestation of the trend away from manufacturing toward services.

To the extent that more R&D is done abroad and the rights to the intellectual property asset are held in the location where the research is done, the magnitude of the receipt and payment flows may be affected. Intellectual property might become "just another company asset" that multinational companies move around the world as they try to optimize the tax situation of their operations. A change in the national location of the in-

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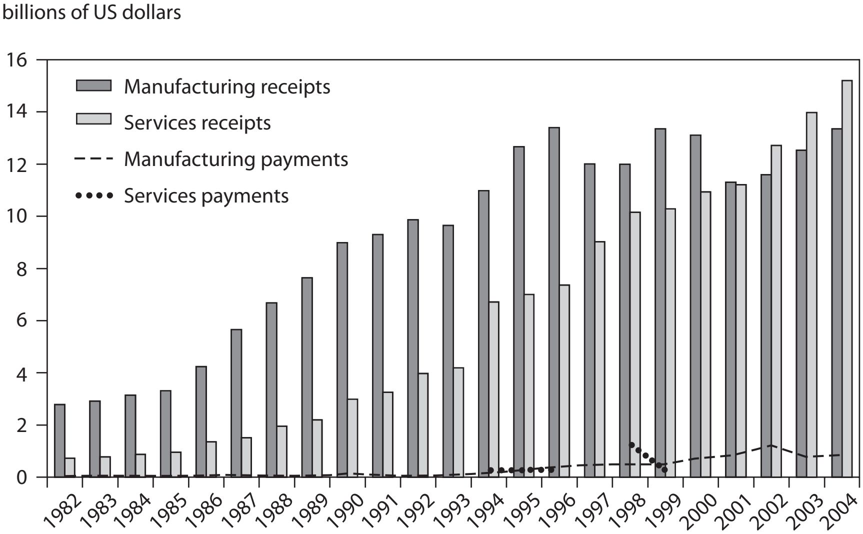
Figure 6.5 US parent firms' receipts and payments of royalties and license fees, by sector, 1982–2004



Note: Detailed payments data in services have only been collected since 1994 and are so small that the data are frequently suppressed by the Bureau of Economic Analysis.

Source: Bureau of Economic Analysis. US Direct Investment Abroad: Balance of Payments and Direct Investment Position data, www.bea.gov (accessed October 1, 2005).

tellectual property asset—say, from being held on the books of a US taxable entity to the books of a foreign entity—would affect the direction of trade flows and perhaps give a mistaken impression of where the innovative activity in fact was taking place.[5]

Another set of data on R&D is cross-border international trade in what is called "research and development and testing services" (available only from 2001 to 2004) (figure 6.6). Overall, exports have increased to $10 billion, against imports of about $5 billion. Almost 90 percent of R&D and testing services exports is intrafirm trade; receipts by US affiliates from their foreign parents represent the majority of that export activity. This direction of trade indicates that R&D and testing services done in the United States by foreign-owned firms contributes in an important and positive way to the

5. Do firms report intellectual property receipts and payments by where the property is actually generated, so that receipts and payments truly reflect cross-border exchange from the location where intellectual property is generated to the location where it is used? The Bureau of Economic Analysis survey is clear in asking that the R&D expenditures be accounted for by location where the research activity is undertaken. But firms pay substantial attention to potential opportunities for tax arbitrage in the booking of intellectual property activities, just as multinational firms are attuned to tax arbitrage throughout their operations. See Desai and Hines (2002) and Blonigen (2005).

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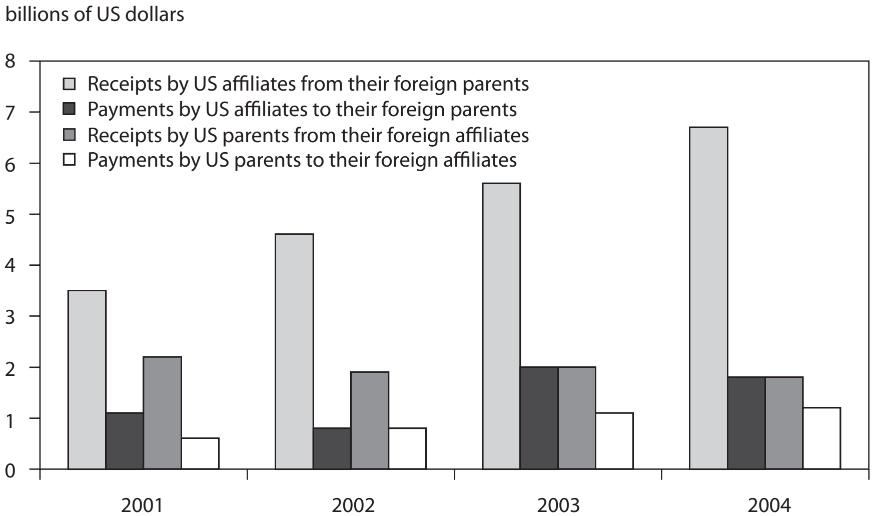
Figure 6.6 US intrafirm trade in R&D and testing services, 2001–04



Source: Bureau of Economic Analysis, *Survey of Current Business,* October 2005, 33 (table E).

exports of this type of international R&D trade. On the import side, the share of trade between affiliated parties has been stable at about 70 percent. Since there has been little change in the value of cross-border trade between the US parent and its affiliate abroad, this suggests that imports of R&D services increasingly come from non-US firms located abroad.

Human Capital and Innovation

The picture of the US workforce—which needs to be able to work with and buy innovative products—is not salutary and is particularly striking when considered against the historical position of the United States. When the generation of soon-to-retire scientists and workers was young, they stood out among the industrial countries for their level of educational achievement. The current generation of US workers, on the other hand, is of middling quality compared with other industrial countries, and the younger-generation pipeline of potential science and technology workers (currently in grades K to 12) appears to be falling behind. So one important perspective on US capability in innovation today is to compare the relative achievement levels of those who are currently old, as well as those who are currently young, to their global competition. (The metric of measuring human capital potential by the sheer numbers of science and technology graduates is not appropriate, as discussed in box 6.3.) In any event, the picture is sobering.

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Box 6.3 How many engineers are really out there?

The concerns are well known: Millions of new engineers from China and India, working at a fraction of US wages, have already started and will in the coming years continue to undermine US engineering employment. US bachelor's degrees earned in engineering in 2000 stood at just below 60,000, down by a quarter in 15 years.[1] In comparison, India in 2004 graduated 185,000 engineers[2] and China in 2003 a staggering 645,000.[3] So at first glance it would seem that many US positions might be under serious threat. (Although note that engineering graduates were in high demand in 2006 topping the lists of both offers and salaries.)

However, as pointed out by the McKinsey Global Institute (2005) in a report on the global labor supply, there are many reasons why an Indian or Chinese engineering graduate may not be truly comparable, and thus in direct competition, with US engineering graduates. Hence the headline numbers for graduates should be approached with caution. The report was based on interviews with locally posted human resource managers from multinational companies, who were asked whether Indian and Chinese graduates, among others, could successfully work at their companies. The response prompted MGI to note the significant obstacles to a successful career for Indian or Chinese graduates at a multinational company, including lack of language skills; low quality of significant portions of the educational system; limited practical skills; lack of cultural fit and interpersonal skills; attitudes about teamwork and flexible working hours; and geographical availability (proximity to international airport).

Indeed, only 10 percent of Chinese engineering graduates were deemed suitable for a career at a multinational company, and 25 percent of Indian graduates. The share of US engineering graduates that would be suitable for a similar career was not directly covered by the MGI report, but the total suitable pool of engineering talent for multinational companies was estimated to have been almost twice as large in the United States in 2003 as in China and India combined. Therefore, it should not come as a complete surprise that total US engineering employment—with many of those engineers working for multinational companies—actually increased between the peak of the boom in 1999–2000 and 2004.

On the other hand, the rapid rise in the sheer number of engineers in China and India will continue to make it more attractive for US and other multinational IT and software companies to conduct research in those countries. It also will make such a research presence in these two countries a competitive necessity for many companies. It should also be kept in mind that an expansion in the hiring

(box continues next page)

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Box 6.3 How many engineers are really out there? *(continued)*

of engineers in China and India can be complementary to, rather than a substitute for, the US engineering workforce, so long as there is demand for local design and implementation for products germane to US needs along with the skilled engineers to do those tasks.

1. In 1985, 77,572 bachelor's degrees were earned, according to science and engineering indicators from the National Science Foundation's Science Resource Statistics WebCASTER database, http://caspar.nsf.gov (accessed March 15, 2006).
2. This figure is from the National Association of Software and Services Companies of India (NASSCOM), www.nasscom.org (accessed March 15, 2006), and India's Ministry of Human Resource Development.
3. National Bureau of Statistics of China, *China Statistical Yearbook 2004,* table 21.11, www.stats.gov.cn (accessed March 15, 2006).

Technological Change, Global Competition, and Education Profiles

Synergies between the skill profiles demanded by globalized services, policy changes in key countries to reduce communications costs, and relative wage differentials around the world are likely to speed the fragmentation and globalization of services. The educational demands for internationally traded services range from low (e.g., call center and transcription services) to high (engineering design and computer programming). But underlying both is a generalized set of skills that is not industry- or firm-specific (Autor, Levy, and Murnane 2001).

Technology unleashed by policy reforms in developing countries augments the global pool of labor with appropriate skills. Thus, the share of the US labor force with the level of educational attainment pitted against workers in developing countries may well *increase* over the next 15 years. At the same time, wage differentials between the industrial and developing worlds remain large. Together, the narrowed education advantage to US workers and the large wage differential favoring some foreign workers, along with rapid deployment of IT and communications, enhance the potential for international trade in services and for job and skill competition and volatility in the United States.

As IT has diffused throughout the US economy, the types of labor potentially affected by technology-enhanced globalization of services are both broader in terms of the sectors affected and higher in terms of the thresholds for educational attainment. Both the absolute and, importantly, the relative position of US educational attainment and the associated return to US workers' skills in the global marketplace therefore are key.

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With a rising skill bar and enhanced global skill competition, how does the United States fare in comparisons of educational attainment and functional skills?

Examining educational attainment by age cohort across countries reveals some of the characteristics of the US workforce and the global competition (figure 6.7). The heart of the current US workforce (ages 45–64) is still the best-educated workforce among the OECD countries. In terms of both secondary and tertiary educational attainment, US prime-aged workers are better educated than similarly aged cohorts in other OECD countries. This cohort of US workers has enjoyed the prosperity of a US economy increasingly technology-driven and integrated with a world that has been, on balance, less educated.

The younger workforce in the United States is not so well positioned, and, with faster technological change and deeper global integration, the stakes are higher. The generation of Americans entering the workforce today (25- to 34-year-olds) barely makes the top 10 ranking and, nearly uniquely among OECD countries' 25- to 34-year-olds, they have on average a lower level of educational attainment than their parents' generation. This younger group faces significantly higher skill demands than did their parents when they entered the workforce. Because technology enables a wider range of jobs to be done remotely, US job seekers face a much more competitive, and available, foreign workforce. And the younger worker today, particularly with less than a tertiary education, is paired with a global workforce that has narrowed the gap of educational attainment. For those educated at the tertiary level, 25- to 34-year-olds in the United States fare substantially better against the global standards,[6] although they are not the best educated, and many other countries are catching up rapidly.

This concern regarding educational attainment is deepened when viewed against survey evidence on the functional skills of the US workforce. The OECD, in its 2003 Adult Literacy and Life Skills Survey (ALL), evaluated three types of functional skills:

- *Prose literacy:* the knowledge and skills needed to understand and use information from texts, including editorials, news stories, brochures, and instruction manuals.
- *Document literacy:* the knowledge and skills required to locate and use information contained in various formats, including job applications, payroll forms, transportation schedules, maps, tables, and charts.
- *Numeracy:* the knowledge and skills required to effectively manage the mathematical demands of diverse situations.

6. Other OECD countries have even bigger problems; their shares of tertiary educational attainment have declined.

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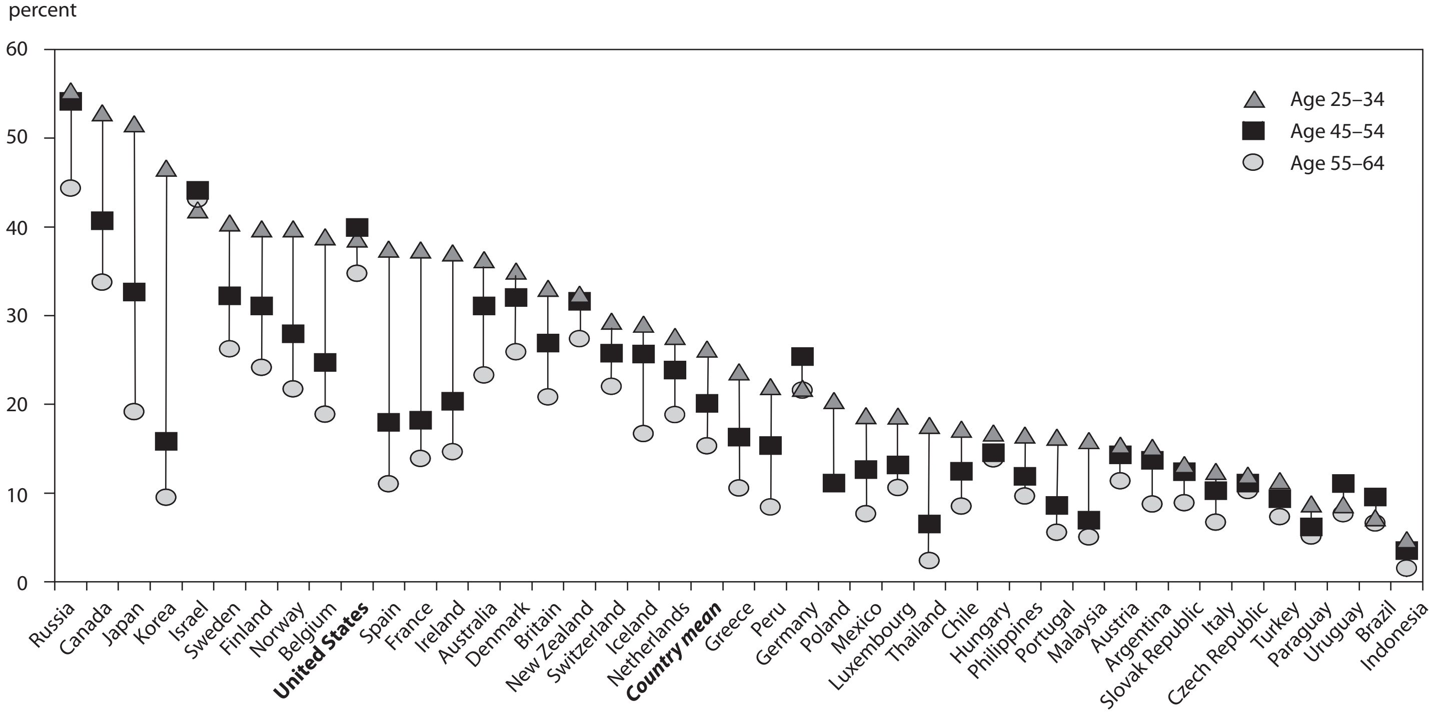
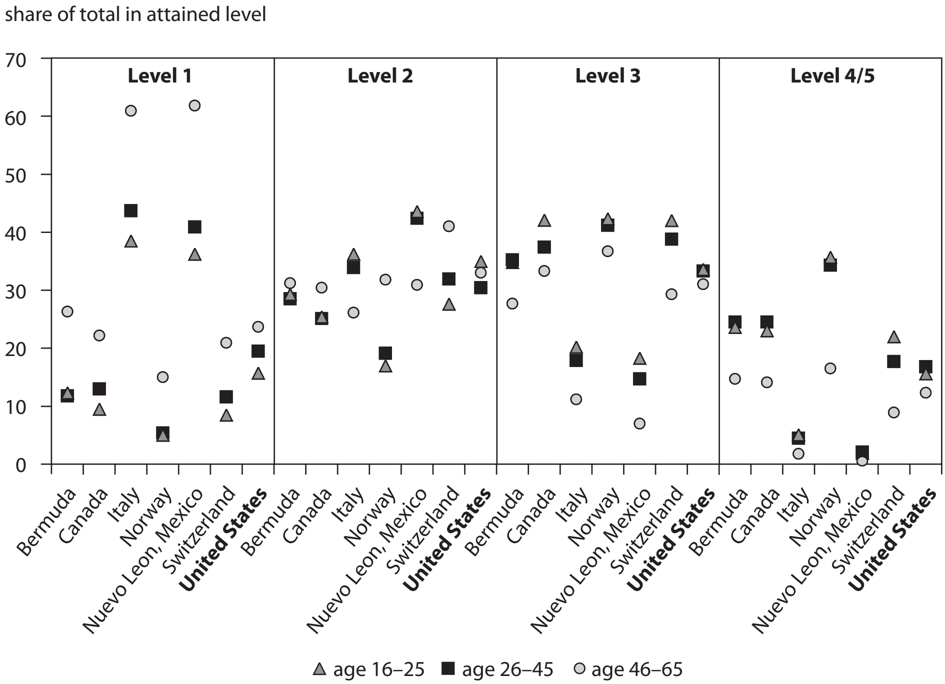
Figure 6.7 Percentage of population that has attained at least tertiary education, by age group, 2003



Note: The definition of "tertiary education" varies between countries but does require an educational content equivalent to a bachelor's degree.

Source: OECD (2005a).

Figure 6.8 Document literacy by age group, 2003 (percent)



Source: OECD, International Adult Literacy and Life Skills Survey, 2003.

On a scale of 1 to 5, the middle range (level 3) is the level considered by experts as a suitable minimum for coping with the increasing demands of the emerging knowledge society and information economy. In 2003, 60 percent of US adults surveyed did not reach this level of proficiency in numeracy, and more than 50 percent did not reach this level of proficiency in document and prose literacy. Only about one-third of US adults achieved the middle range of the scale for these three types of literacy. And it is not that older adults who lower the average: 50 percent of young adults aged 16–25 scored below the minimum proficiency in document literacy (figure 6.8).

An even greater concern is that, compared with 1994 (for which comparisons only for prose and document literacy are available),[7] the share of US adults in the lowest two quintiles increased, the share of adults in the middle range increased just 1 percentage point, and the share of adults in the top two quintiles of literacy fell. Based on these surveys of functionality, the US performance has not improved over the decade, even as glob-

7. The 1994/1998 OECD International Adult Literacy Survey (IALS) uses a similar methodology as does the 2003 ALL Survey. See OECD (2000, 2005b).

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alized technology demands and the US workplace have rewarded higher skills.

Examining other surveys of educational attainment, such as the Trends in International Mathematics and Science Study (TIMSS) and the Program for International Student Assessment (PISA),[8] reveals similar conclusions. Other countries are catching up to or exceeding US levels of educational attainment, even as some US students are doing better on these examinations compared to previous years.

Importantly, these studies also reveal that lower socioeconomic status is correlated with a lower level of educational attainment. A widening disparity of earnings in the United States has already been observed (see chapter 5), so this correlation between socioeconomic status and educational attainment suggests a dynamic that could further widen the existing disparity of earnings and education in the future. Globalized networked technology increases the power of the negative dynamic by adding the wage premium to analytical and judgmental IT-related skills at the top end of the educational distribution, and by heightening global competition at the middle and lower rungs of educational attainment.

In sum, with US educational attainment and functional skill levels on average stagnating, possibly declining and showing a widening dispersion at a time when technology is becoming more sophisticated and other countries are improving rapidly, there is a clear risk that Americans in the future may lose some of the many benefits they have so far enjoyed from globalization. The response must be to improve the incentives to educate people to meet the technological challenges of a globalized economy.

Science and Technology Researchers in the United States

A second concern for the future innovative capacity of the United States is the human capital foundation—people schooled in the sciences and technology. The overall picture of educational attainment is already rather bleak. This does not improve when considering the pipeline of science and technology talent in the United States. Further, the fast pace of technological change also undermines the "stock" of science and technology talent, in that rapid technological change depreciates human skills, just as it depreciates the productivity of physical capital. Rapid skill depreciation suggests that a new approach is needed for ongoing training and "reskilling" so as to keep the US stock of human capital fit for the innovative frontier.

8. TIMSS is a comparison of mathematics and science achievement that has been carried out three times since 1995 by the International Association for the Evaluation of Educational Achievement (IEA), an international organization of national research institutions and governmental research agencies. The PISA is a system of international assessments that measures 15-year-olds' capabilities in reading literacy, mathematics literacy, and science literacy every three years. It is administered by the OECD. See www.pisa.oecd.org (accessed March 15, 2006).

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About 40 percent of all graduate students and all science and engineering PhDs awarded at US universities (rising to more than half in mathematics/computer sciences and engineering) go to non-US citizens and nonpermanent residents. By itself, this may not be an issue, since in the past these students have tended to stay in the United States and contribute to US innovation here. To the extent that the brightest students from around the world come to the United States for science and technology training, this implies that frontier innovation still inhabits the US university and laboratory setting.

However, the most recent information suggests that two factors may be affecting the inflow and retention of foreign talent. First, with rapidly improving career and business opportunities in the home countries of many foreign students (notably India and China), an increasing proportion of these students appear to be returning home. Not only does this reduce the US return on its investment for having funded a US education for these students, but it also reduces the stock of highly educated workers in the US university and research setting (and increases that stock abroad).

Given these science and technology demographics, and in conjunction with the locus of demand for technology products shifting to rapidly growing economies abroad, it is not surprising that R&D facilities are being opened in foreign countries. A further impetus to this global shift of R&D is the sheer numbers of science and technology graduates in some countries. Against the US graduation numbers of 60,000 engineers in 2004, India graduated about 185,000 in 2004 and China some 645,000 in 2003 (see box 6.3). Many of these graduates are not researchers, and their local environment will not spawn or support innovation, but the fact is that the global pool of science and technology graduates increasingly is not located in the United States. This trend comes at a time in the 21st century when literacy, numeracy, and analysis—skills developed in a program of study in science, engineering, and technology—are needed pervasively throughout the process of research, design, production, marketing, and sales of goods and services both at home and abroad.

Globalization of Venture Finance

How are globalization, venture capital, and innovation linked? On the one hand, the globalization of venture finance, whereby finance raised in the United States is extended to foreign firms to engage in innovative activities, could dilute the US economic dynamic, putting future US prosperity at risk. On the other, this globalization of venture finance could spawn the development of more ideas, and at less cost, which in turn can be taken to the marketplace, thereby bolstering US productivity and growth. The possible scenarios start with the question of whether US venture finance has globalized. A second set of questions considers the type of activities being undertaken abroad and their potential impact on US performance.

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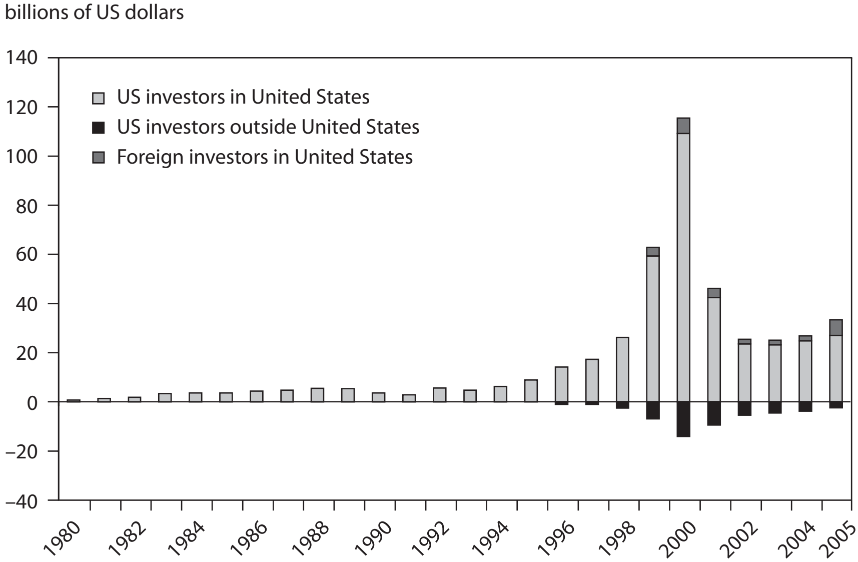
Figure 6.9 Total venture capital invested, by source and destination, 1980–2005



Source: Thomson Financial VentureXpert database.

According to the Thomson Financial VentureXpert database, venture finance has been globalized for some time. In the 1990s, 5 to 10 percent of US-raised venture finance was spent on firms in foreign countries and about 5 percent of foreign-raised venture capital funded US firms.[9] In the first couple of years after the Internet and stock market crash in the United States (2001–02), foreign firms received almost 20 percent of US-raised venture finance; but that share has since fallen back to under 15 percent. The number of foreign countries receiving venture finance has increased, particularly in the last 15 years, with firms in more than 50 countries currently receiving funds. China has been among the top five recipient countries in seven of the last 12 years, whereas India has appeared only once among the top five. Of course, these shares of total funding mask the dramatic boom and crash in venture finance, which is the overwhelming hallmark of the period (figure 6.9).

Waves of financing of IT-related activities appear in these data, with IT investments receiving from one- to three-quarters of all venture finance. Three successive waves can be identified. In the 1980s, venture finance supported computer hardware; in the 1990s, the Internet wave dominated the data; and following the Internet crash, financing associated with software and computer services increased. Other technologies, such as those

9. See http://banker.thomsonib.com/ta/ (accessed October 1, 2005).

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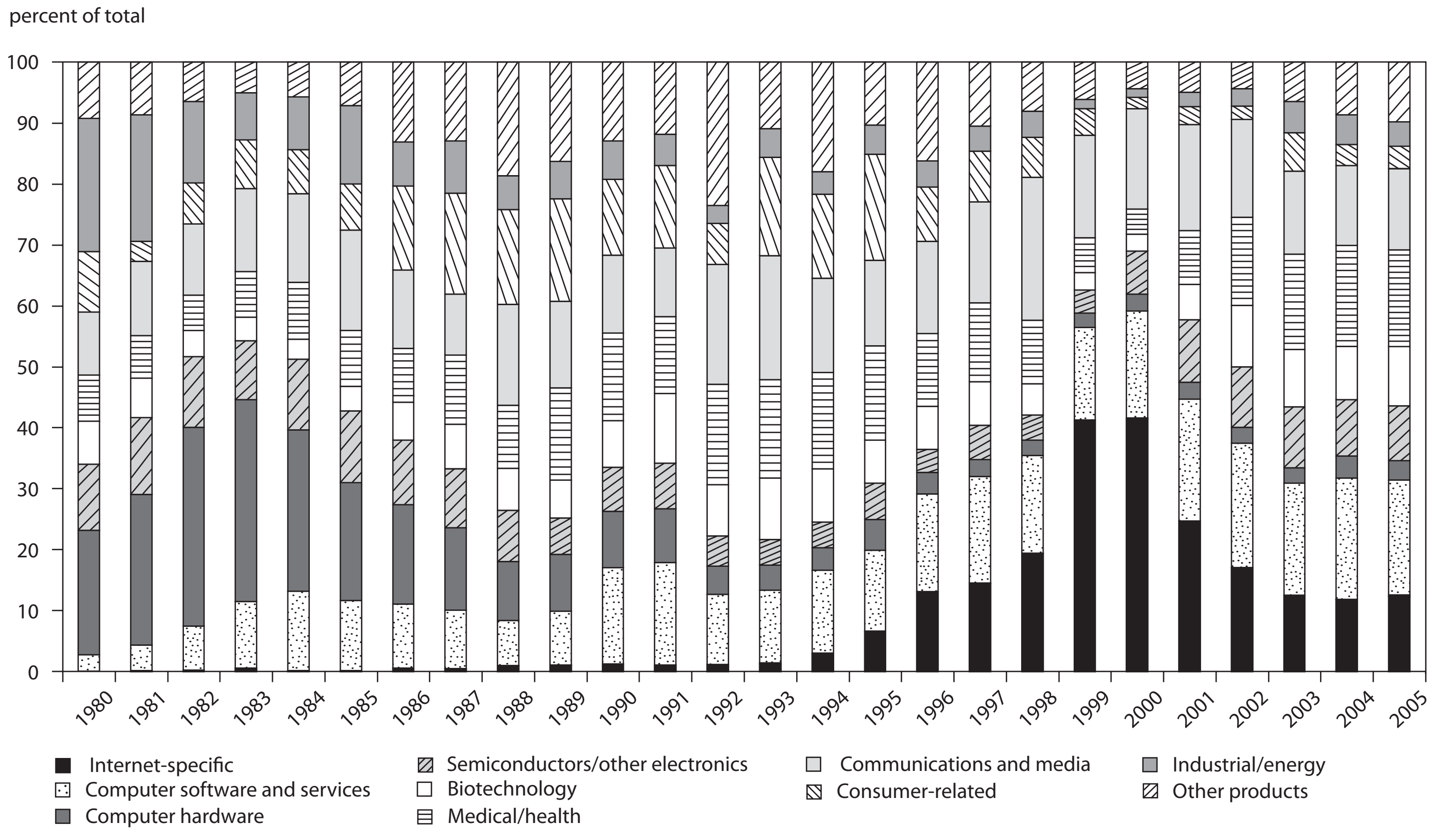
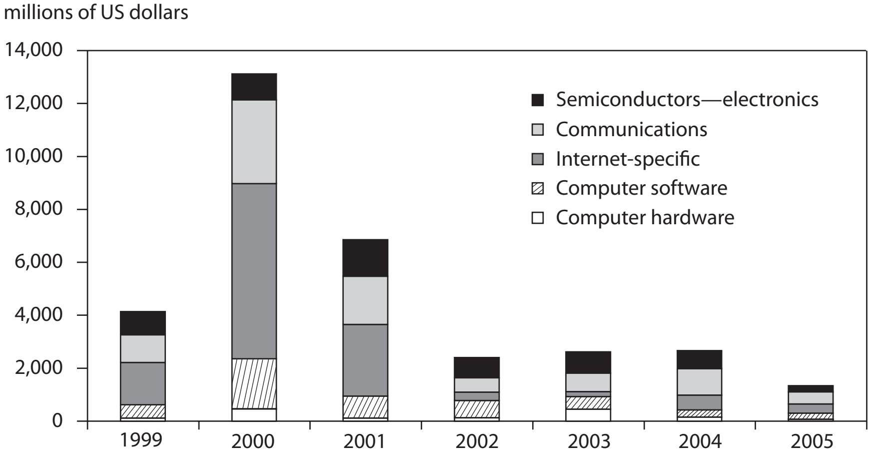
Figure 6.10 US venture capital investments in the United States, by industry, 1980–2005



Source: Thomson Financial VentureXpert database.

Figure 6.11 US venture capital flows to the rest of the world, 1999–2005



Source: Thomson Financial VentureXpert database.

associated with biotechology and medical/health account for between 15 and 30 percent of financing, generally receiving a higher percentage when IT's fortunes wane. Communications and media firms increased their share in 2005, whereas the share for consumer-related products has fallen since the mid-1990s (figure 6.10).

A clear trend emerges with respect to the stage of financing supported by venture finance. It is common to disaggregate venture finance into five categories: seed or start-up, early stage, expansion, later stage, and buy-out or acquisition. The share of venture finance going to seed or start-up ventures in the United States has fallen throughout the period covered by the Thomson database, with the declining share accelerating since 1995. On the other hand, against a backdrop of much smaller dollar values and shares, the share of start-up and early-stage funding to foreign companies does not exhibit this declining trend.

The focus on later-stage investment in the United States may imply that venture finance goes more to firms that are beyond the concept and vision stage and, rather, are expanding in a more mature market. If so, then the globalization of venture finance may point to enhanced productivity growth in the United States coming more through ideas being implemented and brought to market, rather than through "next-big-thing" innovation. On the other hand, funding of start-ups abroad may indicate a greater willingness of US venture firms to take small dollar-value risks abroad that they are not taking at home.

Figure 6.11 focuses attention on just the IT sector and on US venture funding that goes abroad. The technology cycle is obvious, but so too is

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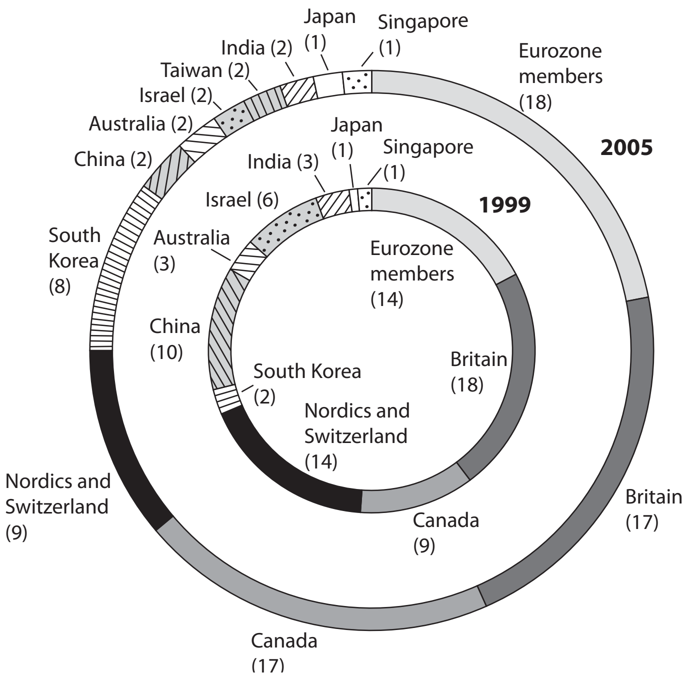
Figure 6.12 Top countries and regions receiving US venture finance, 1999 and 2005, share of total (percent)



Note: Other countries excluded amount to approximately 20 percent in 1999 and 2005.

Source: Thomson Financial VentureXpert database.

the balance between the various subsectors of the IT industry. In these data, the shift toward spending on services and software, rather than hardware, is less apparent. That is, there is about equal spending on ventures in hardware and software. This is consistent with the spending data discussed in chapter 2—that is, spending on IT hardware in developing countries was relatively larger than for IT software and services but expected to become more balanced over time.

Figure 6.12 shows the top countries and regions receiving US venture finance and the distribution in 1999 and 2005. The EU countries, United Kingdom, and Canada are the largest recipients of funds. Considering the geographic pattern in 2005 versus 1999, it is clear that while the industrial countries continue to dominate venture investment, there is rising interest in funding portfolio companies both in the developing world and in countries with key skills such as Israel.

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