4

Japan

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4.1. Introduction

The Toyota Commemorative Museum of Industry and Technology gives its visitors much to ponder. Established at the site in Nagoya where in 1911 Sakichi Toyoda founded his automatic loom factory, the basis of the family fortune which later funded his son Kiichiro's development of automobile production, the museum was opened on June 11, 1994, on the 100th anniversary of Toyota's birth. It is a popular stop on field trips for Japanese schoolchildren, who are required to study the automobile industry in the third grade. The messages which Toyota wishes to instill in its young visitors are the importance of "making things" and of "creativity and research." And confronting all museum visitors upon entry, having central place in the vast and largely empty first room of the exhibits, is Sakichi Toyoda's one-of-a-kind vertical circular loom.

As described in the Museum's catalog, "Even in the closing years of his life, [Sakichi Toyoda] continued to work to perfect the [vertical] circular loom. To symbolize this unfailing spirit of his, we are proud to exhibit the only circular loom he developed that is still in existence." This first "Symbolic Exhibit in the Museum," whose distinctive outline serves as the Museum's logo, was manufactured in 1924. Although Toyoda first applied for a patent in 1906 on a circular loom design, and eventually held a patent in eighteen countries for the concept, and although the circular loom is quieter than flat looms (meaning it is also more energy efficient), and able to produce longer bolts of cloth without seams, the circular loom was never produced in volume. In fact, no sales, let alone profits, were ever made from this innovation. In 1924, Toyoda also perfected the Type G Automatic Loom, a flat "non-stop shuttle changing loom"—embodying an incremental but significant improvement on previous loom technology—which became Toyota's all-time bestseller in the sector. The Type G Loom, however, is not the Museum's symbolic first exhibit or logo; instead, it takes its place chronologically back in the succession of exhibits.

Why does one of Japan's, and the world's, leading manufacturing corporations choose to feature an innovative product, which was never brought successfully to market nor became any sort of technological standard, as the emblem of its tradition of industry and technology? Neither corporate public relations efforts, nor Japanese culture, are generally known for their sense of deliberate irony. Neither is known for rewarding quixotic individual quests of little practical value to the larger purpose, either. Whether intentional or not, perhaps the message is the one given at face value: that technological innovation is its own reward, and should be appraised on its own noncommercial merits. While the process of innovation is certainly related to a corporation's profitability, there is no easy one-to-one relationship between the best innovation and the best

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economic results, beyond the fact that people driven to innovation over the long-run have the fundamental potential for success.

What is true about innovation and performance for Toyota may well be true for Japan as well. The story of Japan's miraculous economic development after World War II is engrained in the world's memory. No other large country had ever come so far, so fast. No other country from Asia (or anywhere else outside of Europe's direct lineage) had attained Western levels of technology and wealth, was treated as an equal or even feared as an economic competitor by the United States, nor had taken leadership in many advanced industrial sectors. No other country in history had racked up so many consecutive years of positive income growth. By the end of the 1980s, with the relative decline of American economic performance, and the influence of Japanese investors felt worldwide, scholars and pundits alike were advancing a "Japanese model" of economic management. This model included supposedly distinctive aspects of Japanese policy and corporate practice, including industrial policy, an emphasis on incremental innovation of industrial processes, relationship banking between business firms and their "Main Banks," and export orientation. There seemed to be a clear message that Japan, as part of this model, had assembled a "national innovation system" which conferred significant advantages for growth.

Ten years later, the economic world has been turned upside down. It is the United States whose system is now held up as a model for economies around the world, which has run several years of strongly positive growth in a row, and which is considered the home of cutting edge technologies in the most attention-getting sectors, like information technology and biotechnology. It is Japan which is now caught in the midst of an economic malaise which it cannot seem to understand, let alone shake. This nearly complete reversal of fortune in Japan would seem to be a critical case study for understanding the determinants of national economic performance. Especially given the fear on the part of some American commentators and officials lasting into the mid-1990s that Japan was building an insurmountable lead in "critical technologies,"—as exemplified by the pressures for Sematech—it is important to distinguish perception from reality in both technological and economic performance.

From the perspective of 2001, after 10 years of slow or negative growth in Japan, there is reason to wonder whether Japanese technical prowess evaporated for some reason, whether national innovation systems can be somehow appropriate for capitalizing on particular waves of technological development and not others, or whether perhaps technological innovation alone is insufficient to guarantee good economic performance. On this last point, it should be recognized that the bulk of the Japanese economy conducts its business largely independent of high-tech or anything resembling technological innovation. In this, however, Japan is completely normal, not distinctive—all advanced economies, including the United States, have vast shares of their resources employed in retail, service, governmental, and even manufacturing activities where technical change does not significantly alter productivity. There are only so many papers an academic can produce, so many patients a nurse can tend, so many students a teacher can teach, and so many 747s skilled mechanics can assemble, even as the IT revolution proceeds. A technological change must be very great in effect, or unusually wide in applicability as well as diffusion, to change a country's overall economic performance.[1]

In that light, it is worth emphasizing just how serious the Japanese economic downturn of the last decade has been as compared to the growth seen in the previous three decades in Japan or to the performance of the other industrial democracies. In the post-war period, no developed country lost as much growth versus potential in a recession as Japan did from 1990 to the present (a cumulative output gap in excess of

[1] This is in a sense the message of Oliner and Sichel (1996), that to that point, investment in computers and related equipment was simply too small a share of the U.S. economy to explain much in the way of swings in American growth. Oliner and Sichel (2000), by contrast, updated their results once there had been sufficient investment for the IT sector to matter.

15 percent of a year's gross domestic product (GDP)[2]), and no developed country's banking crisis imposed as high a direct cost to its citizens (upwards of 15 percent of a year's GDP in bad loans requiring public bailout, and still rising—compared to the entire U.S. Savings and Loan clean-up which cost less than 3 percent of a year's GDP). Corporate bankruptcies have been at all time highs, and unemployment has risen to levels never before seen in Japan, with no end to either trend in sight. Understanding this remarkable deterioration of Japanese national economic performance has to be a central concern of any assessment of the roles of various factor in economic growth, and, given the size of the change, thereby sets a very high bar for the degree to which technological innovation must have changed in this instance to have played a leading role.

This chapter is organized around the relationship between Japanese technological innovation and the sustained decline in Japan's growth rate in the 1990s as compared to the previous two decades (the very high growth rates of the catch-up period in the 1950s and 1960s are assumed to have been unsustainable). Examination of the huge shift in Japanese economic performance raises three aspects of the relationship between innovation and growth for consideration. The first aspect is how macroeconomic performance can radically change without any accompanying change in the inputs to the innovative process. Japan's national system of innovation is largely unaltered in the 1990s from the system that existed during Japan's glory days, with a few minor alterations probably including improvements in innovative capacity.[3] The second aspect is the possibility that maintenance of a sustained high level of technological innovation can continue even as the economy surrounding the national innovation suffers. In today's Japan, the production of high-tech patents and high-end exports, that is, the measurable output of innovation, continues largely undiminished despite the erosion of macroeconomic conditions. It is usually assumed that, during harder economic times, financing and long-term investment for innovation are harder to come by, yet in the case of Japan in the 1990s that constraint appears not to have arisen.

The third aspect is how, in an industrial democracy with free flows of information, advances in productivity can remain in a limited number of sectors without diffusing across the economy. This is both a question of social organization and of the nature of the technology in question. It has long been known, for example, that Japan has a "Dual Economy" with a gap in technical achievement between the highly competitive export sector and the backwards domestic manufacturing, retail, and service sectors; this gap was true during the years of the Japanese miracle, and remains true if not widening today. In the United States, by comparison, there is an open debate whether the current such gap will persist. Gordon (chapter 3) argues that most of the technical advancement in the United States in the 1990s was confined to the manufacture of information technology, because of the limited nature of the IT revolution. On the other side, the Council of Economic Advisers (CEA) (2001) argues that IT actually diffused into use much more widely in the U.S. economy than previously believed, both because it is a "transformative" technology (applicable throughout the economy) and because the U.S. form of economic organization is prepared to take advantage of such a technology; that report explicitly contrasts U.S. flexibility in technological adoption to the barriers to the reallocation of capital and labor in the Japanese economy. Even if valid, such a characterization of Japan emphasizes that the link between technological innovation and national economic performance is intermediated by factors which have little to do with innovativeness per se, and which may affect national productivity more broadly as much as they interfere with technical diffusion.

These three aspects of the Japanese experience—that innovation inputs and outputs

[2] See Posen (1998: Appendix 1; 2001) for discussions of various means and results for estimating the Japanese output gap.

[3] A similar observation can be made with reference to the United States, which underwent little change in the structure of the innovation system, but a radical change in performance, between the 1980s and 1990s.

remained unchanged even as national economic performance varied widely, and that factors outside the national innovation system as traditionally defined have to be invoked to make technology play a leading explanatory role—could be troubling if one insisted on believing that technological innovation and national economic performance are intimately related. The experience of Japan would seem to indicate that such a belief should not be too tightly held. Accepting an imperfect, or at least very long-term, connection between the two is to be preferred to making a circular argument, as some do, that the reason Japanese economic performance is poor is because the entire national innovation system that once worked for Japan is "inappropriate" for today's world and technology, and the reason that we know the innovation system is inappropriate is that performance is poor. There are many other factors that determine a national economy's macroeconomic performance over periods of several years besides its technological capabilities, including economic management of the business cycle and the financial system, and there are many factors determining the ability of a country to innovate, beyond its growth rate. The inability of Japan's world-beating process innovation and productivity in its export manufacturing sectors to limit the downward swing of the rest of the Japanese economy is an important reminder of just how independent or exogenous technological development is from most of what economics is about—as was the case for Sakichi Toyoda's circular loom.

4.2. The Facts of Japanese Growth Performance: Ongoing Decline in Growth, Sharp Fall-off in the 1990s

4.2.1. What Happened in Japan

The decline of economic performance in Japan in the 1990s was a sharp and lasting contrast to what went before. From 1990 to 1997, first there was a fall in asset prices, then corporate fixed investment, then in housing starts, then inventories, and then finally consumption. The stock market peaked in December 1989, and land prices reached their height a year later. The OECD has estimated that the net wealth lost in the asset price declines of 1989–97 was on the order of 200 percent of a year's GDP, with 50 percent of those losses borne directly by households (at least on paper). Officially, the recession began in February 1991, and lasted until October 1993 (see Table 4.1). As Motonoshi and Yoshikawa (1999) observe, corporate investment was the key variable, with the fall in investment in 1992–4 and in 1998 more than two standard deviations in size from the 1971–90 average year-on-year movements. Small and medium enterprises were particularly hard hit as the 1990s wore on, arguably due to a credit crunch as liquidity and credit standards tightened in the second half of the decade.[4] Size aside, this is actually the usual sequence of movements in demand components for a business cycle downturn following a bubble. What is unusual among the demand components listed in Table 4.1 is the persistent flatness and in fact decline in consumption growth once things turned sour.

The contrast was striking with the outstanding growth performance of the Japanese economy in the post-war period up until 1990, although every decade showed a slowdown in average growth rate (see Table 4.2). In both the 1970s and 1980s, real GDP averaged 4.0 percent or more annually, as opposed to the 1.5–2.5 percent a year growth seen in most of the other OECD economies including the United States. Despite claims by some about Japanese households' reluctance to consume, prior to 1990, private consumption growth was positive, in fact more than comparable to the growth in residential investment, and even

[4] MITI *White Paper on International Trade* 1999 characterized matters: "[T]he lack of depth in capital supply—for example in the setting of interest [rate] levels in line with risk—in terms of the various capital intermediation routes obstructs the smooth supply of capital to companies with credit ratings below a certain level, such as middle-ranked and small and medium companies [as well as credit for] new businesses, all of which have limited physical mortgage capacity." And the Japanese banking system which depended upon land collateral as the basis for all credit assessments, ceased to lend when the real estate market collapsed, except to rollover bad debt to borrowers who had only land as repayment.

TABLE 4.1
Contribution of Demand Components (percentage of GDP)

	GDP growth	*Consumption*	*Housing investment*	*Fixed investment*	*Inventory investment*	*Public consumption*	*Public investment*	*Exports*	*Imports*
1980	2.8	0.6	−0.6	1	0	0.3	−0.5	1.4	0.7
1981	3.2	0.9	−0.1	0.5	0	0.5	0.3	1.2	0
1982	3.1	2.6	0	0.2	0	0.3	−0.2	0.1	0.2
1983	2.3	2	−0.3	0.2	−0.3	0.3	−0.2	0.5	0.2
1984	3.9	1.6	−0.1	1.5	0	0.2	−0.3	1.5	−0.8
1985	4.4	2	0.1	1.7	0.3	0	−0.5	0.6	0.1
1986	2.9	2	0.4	0.7	−0.2	0.5	0.2	−0.7	−0.1
1987	4.2	2.5	1.1	0.9	−0.1	0.2	0.5	−0.1	−0.7
1988	6.2	3.1	0.7	2.3	0.6	0.2	0.3	0.6	−1.6
1989	4.8	2.8	0.1	2.4	0.1	0.2	0	0.9	−1.6
1990	5.1	2.6	0.3	2	−0.2	0.1	0.3	0.7	−0.8
1991	3.8	1.5	−0.5	1.2	0.3	0.2	0.3	0.6	0.3
1992	1	1.2	−0.3	−1.1	−0.5	0.2	1	0.5	0.1
1993	0.3	0.7	0.1	−1.9	−0.1	0.2	1.2	0.2	0
1994	0.6	1.1	0.4	−0.9	−0.3	0.2	0.2	0.5	−0.8
1995	1.5	1.2	−0.3	0.8	0.2	0.3	0.1	0.6	−1.4
1996	5.1	1.7	0.7	1.8	0.4	0.2	0.8	0.8	−1.3
1997	1.4	0.6	−0.9	1.2	−0.1	0.1	−0.9	1.4	−0.1
1998	−2.8	−0.6	−0.6	−2.1	−0.1	0.1	0	−0.3	0.9
1999	0.6								
2000	1.9								

Source: Motonishi and Yoshikawa (1999: Table 1).
Note: 2000 GDP Growth is OECD Forecast, November 2000.

TABLE 4.2
Long-Term Performance of the Japanese Economy

	Average annual real growth rate (percent)			
	1961–70	*1971–80*	*1981–90*	*1991–7*
GDP	10.2	4.5	4	1.7
Private consumption	9	4.7	3.7	2
Public consumption	4.8	4.8	2.5	1.9
Residual investment	16.8	3.2	3.9	−1.8
Business fixed investment	16.6	2.8	8.1	0.6
Public investment	14.4	5.9	0.8	4.9
Exports	16.1	9.7	5.4	5.1
Imports	14.7	5.9	6.3	4.3
Employee compensation	11.1	5.8	3.7	2.1
Disposable income	9.5	4.8	3	2.2

Source: OECD Economic Survey 1997–8.

meeting or exceeding the rate of growth in disposable income from 1971 to 1997. Meanwhile, exports rate of growth slowed every decade. The presumptive bubble can be seen in the 8.1 percent growth in business fixed investment from 1981 to 1990, especially when one considers that Japan was in recession up to the end of 1984, meaning most of that investment was concentrated in just five years.

Looking a bit more descriptively, it is possible to follow Yoshikawa (2000) and break up post-war Japanese economic development before 1990 into two periods. From 1955 to 1972, the Japanese economy grew by an average 10 percent a year. Like continental Europe during its period of post-war rebuilding, the Japanese workforce started with extensive technological skills and other human capital close to the U.S. level (Goto and Odagiri, 1997). Like continental Europe, there was a rapid shift of households from rural to urban areas, of production from agricultural to industrial products, increasing the number of households. And, like in post-war continental Europe, rising real incomes fed and were fed by demand for new consumer durables. The similarity with Germany up to the first oil shock is especially close; Japanese industry made rapid technical progress in chemicals, iron and steel, paper and pulp, and in transport machinery. Japan, like Germany, accumulated a great deal of capital with its high savings rate, and ended up having a capital-to-labor ratio of almost twice that in the U.S., despite the ongoing increase in manufacturing hours worked.

From 1972 to 1990, Japanese growth continued at higher than American or even European rates, but slowed noticeably. There is some dispute over whether this limited slowing can be attributed to the oil shocks as a *deus ex machina* in Japan, the way the oil shocks seem to have been associated with the decline in productivity growth in the United States and elsewhere around the mid-1970s.[5] In any event, there were other factors at work, just as in the United States it became clear that the actual productivity decline began before the oil shock. At some point in the 1970s, Japan reached the technological frontier in many advanced manufacturing sectors, having "caught up" to the United States, or even surpassed it in some areas considered high-tech. Also, the shift of employment from agriculture to manufacturing, and the shift in residence from rural to urban, was largely completed. Both of these contributed to a decline in the "easy" ways to add growth.

Meanwhile, Japan actually adapted well to the aftermath of the oil shock, exporting large quantities of more fuel efficient machinery and autos to both the West and to newly developing east Asia. By the mid-1980s, people believed that the price of land could never go down in Japan, that Japanese exporters would dominate world markets in many leading industries on an ongoing basis, and that Japanese investors would acquire significant ownership over much of the world's prized assets. These were the days of "Japan as Number One".

The current sense of crisis in Japan and abroad about the Japanese economy did not arise until after the aborted recovery of 1996—in fact, until then positive perceptions about the Japanese economy remained prevalent on both sides of the Pacific. This was understandable given the not unprecedented nature of the 1991–5 slowdown, the ability to blame it temporarily on the yen's rise, and the apparent signs of recovery in 1996 following one program of true government fiscal stimulus. The severe but normal downturn of the 1990s only persisted and got worse due to the government ignoring mounting financial fragility and pursuing pro-cyclical monetary and fiscal policies (Posen, 1998). In particular, the combination of a consumption tax increase in April 1997 and the contractionary effects of the Asian Financial Crisis, as well as a mounting pile of bad bank loans in excess of 10 percent of GDP, cut off a nascent recovery which started in 1996.[6] The surprise collapses in November

[5] The leading figures in this debate over the causes of Japan's first slowdown were Dale Jorgenson on the oil shock side and Angus Maddison arguing against such an attribution.

[6] Boltho and Corbett (2000) note that 35 percent of Japanese exports went to the crisis countries before mid-1997, and these declined by 27 percent after the crisis hit, a direct loss of 1.5 percent of Japanese GDP.

TABLE 4.3
Monetary and Financial Developments in the 1990s (Annual Percentage Change)

	GDP deflator	*CPI*	*WPI*	*Real yen/ U.S.$*	*Land price*	*Stock price*
1991	2.89	2.3	−1.29	72.2	0.55	2.38
1992	0.94	2.08	−1.69	67.4	−5.11	−32.03
1993	0.44	0.91	−4.07	62.4	−5.13	16.91
1994	−0.62	0.5	1.25	58.5	−3.82	0.47
1995	−0.38	0.07	−0.06	61.5	−4.3	−4.9
1996	−2.23	0.3	−0.33	71.2	−4.43	5.47
1997	1	2.23	1.42	79.4	−3.62	−20.85
1998	0.17	−0.32	−3.64	76.8	−4.38	−15.37
1999	−0.79	0	−4.12	76.9	−5.67	23

Source: Bernanke (2000: Tables 7.1 and 7.2).
Notes: Real yen/U.S.$ rate is computed with January 1979 = 100. Land price is from index of commercial buildings in urban areas. Stock price is percentage change in Topix index. CPI: Consumer Price Index; WPI: Wholesale Price Index.

1997 of Yamaichi Securities, one of four major securities houses in Japan, and of Hokkaido Tokashokku Bank, the dominant bank on the north home island and one of the top twenty banks—despite the efforts of regulators at the time to maintain a convoy system keeping all banks afloat and all problems hidden—fed a financial near-panic among Japanese savers, as well as among counterparties with Japanese banks. The official recession lasted from June 1997 to December 1998.

From mid-1997 through the first quarter of 1999, there was a breakdown in Japanese financial markets, with credit growth collapsing, the banks subject to very high "Japan premia" in interbank markets (when they could borrow at all), a rise in the public's holdings of currency relative to bank deposits (indicating disintermediation from the banking system), and a deflationary trend on all available measures that continues today[7] (see Table 4.3). Land prices declined unremittingly throughout the period, while the stock market declined by double digit amounts in two of the last three years (and has again in 2000 to date). The combination of deflation and financial fragility created a vicious cycle of mounting real debt, foreclosed but unsold collateral, and adverse selection in credit markets.[8] The situation only stabilized with the implementation of major financial reforms and recapitalization of part of the banking system in the first quarter of 1999—but no more than stabilized—with over half of the Japanese banking system still inadequately capitalized, with nontransparent accounting of nonperforming loans, and therefore rolling over bad loans while making risky choices with new credits (gambling on resurrection).

On the real side of the economy, Japanese unemployment has risen to exceed that in the United States beginning in mid-1998, going from 2.3 percent in 1990 to 4.9 percent in mid-2000. While the American unemployment levels are likely to rise again as the cycle turns down, Japan is estimated to have sufficient "hidden" unemployment, that is, employees officially still on the payroll of firms who do little productive work and who in some instances are not even paid, to double the national unemployment rate. Changing exchange rates make it difficult to compare levels of wealth and income between countries, but real per capita GDP measured on domestic data has grown at only a 0.6 percent compound rate since 1990 in Japan, while the rate of growth in U.S. real per

[7] In Japan, as in all economies using standard baskets to compute deflators, there is an inherent positive bias in the consumer price index (CPI) and other price indices. This bias is on the order of 1.0–1.5 percent in Japan, according to the Bank of Japan's own calculations, meaning effective deflation arguably has been present since 1992.

[8] See the chapters by Bernanke, Glauber, Shimizu, and Posen in Mikitani and Posen (2000).

TABLE 4.4
General Government Deficits (Excluding Social Security) and Gross Debt (National Accounts Basis)

	Deficit (percent of GDP)	*Gross debt (percent of GDP)*		
	Japan	*Japan*	*United States*	*Germany*
1983	6.2			
1984	4.6			
1985	3.4			
1986	3.9			
1987	2.4			
1988	1.6			
1989	0.7			
1990	0.6			
1991	0.8	57.9	71.4	40.1
1992	2	59.3	74.1	43.4
1993	4.8	63.7	75.8	49
1994	5.1	68.8	75	49.2
1995	6.4	76.2	74.5	59.1
1996	6.9	80.5	73.9	61.9
1997	5.9	84.6	71.6	62.8
1998	7.1	97.4	68.6	63.3
1999	8.9	105.3	65.1	63.5
2000	8.5	112.8	60.2	63.5
2001	8.1			

Source: OECD Economic Outlook. Note: 2000 and 2001 are projected values.

capita income has been nearly three times as great (1.7 percent compound annual rate) over the same period. In the two major "Global Competitiveness Surveys," Japan's position has declined throughout the 1990s.[9]

As of writing, Japanese annual household savings have risen to 13 percent of GDP, while in the United States, the share of private savings out of annual income have sunk towards or even below zero. Of course, public sector savings in the two countries have shown divergences in the opposite direction over the decade, with the U.S. Federal Government moving into surplus, and the Japanese government exceeding Italy and Belgium in terms of high gross debt-to-GDP ratios[10] (see Table 4.4). This erosion of the Japanese government's balance sheet has more to do with declining tax revenues in a time of declining growth than with any ambitious public spending or tax cut programs (always far more promised than implemented, with the exception of September 1998).

4.2.2. What this Means for Japan

The mainstream macroeconomic explanation for Japanese economic decline in the 1990s is a combination of a normal negative demand shock, an excessive financial multiplier due to

[9] The IMD survey ranked Japan as the most competitive economy in the world through the early 1990s, downgraded it to fourth in 1995, and to seventeenth in 2000; the World Economic Forum had already dropped Japan to thirteenth by 1996, and the economy fell further in the rankings to twenty-first in the 2000 survey.

[10] It should be noted, however, that Japanese government net debt is not necessarily or even obviously on an unsustainable path since all of the debt is denominated in Yen, less than 6 percent of the debt is held abroad, and close to a third of the government debt is held by public agencies themselves.

TABLE 4.5
Real Interest Rates (Government Long Bond Yield Minus Expected Inflation)

	1990–1	*1994–5*	*1998–9*
Japan	4.9	3	1.8
United States	4.2	4.6	3.8
Germany	4.5	4.3	3

Source: Boltho and Corbett (2000: Table 3).
Note: Expected inflation taken from OECD's year-end inflation forecasts.

TABLE 4.6
Changes in Business Start-ups and Closures (Annual Average Rate of Change)

	Start-ups	*Closures*
1975–78	5.9	3.8
1978–81	5.9	3.7
1981–86	4.3	4
1986–91	3.5	4
1991–96	2.7	3.2

Source: Management and Coordination Agency, Statistical Survey of Business Establishments and Enterprises.

bad loans feeding back into the broader economy through connected lending and regulatory forbearance, and severe fiscal and monetary policy missteps turning that into debt deflation. Consistent with this view, there has been no decline in Japanese purchasing power or terms-of-trade (see Table 4.3). Unemployment has risen, and capacity utilization has declined, while prices have fallen. Real interest rates have declined, despite the deflation, consistent with a lack of demand for investment (see Table 4.5). The rate of business creation has declined in Japan, with the number of start-ups now growing more slowly than the number of business bankruptcies and closures. In fact, that imbalance was already true even in the bubble years of the late 1980s, when the number of business closures per year increased more rapidly than the number of business start-ups (see Table 4.6). The trends in "creative destruction" in the Japanese economy display no sharp break with long-run trends, especially given the cyclical downturn.

In short, there is no evidence of a direct hit to Japanese productive capability or to the basic structures of the economy from what it was when it was idolized in the late 1980s. There is no question that productivity growth has declined in Japan in the 1990s (see Tables 4.7 and 4.8). According to the *MITI White Paper on International Trade 1998*, total factor productivity (TFP) stagnated from 1990 to 1997, after growing by 1.0 percent a year in the 1980s. But measured productivity performance is pro-cyclical in most economies, because when there is an economic slowdown, firms do not shed labor as rapidly as output falls.[11] In Japan, firms have proven especially reluctant to let workers go even as production has been cut, exacerbating this effect. It is worth noting that the estimates of both Wolff (1999) and OECD (2000) indicate that the difference between Japanese and U.S. (or German) labor productivity growth only widens starting in 1995, after the American boom and the Japanese second recession/financial breakdown began (see Table 4.8).

Furthermore, for a large, diversified, and developed economy, like Japan, a negative supply shock (i.e., a decline in productive capacity rather than an idling of extant capacity) should be reflected in a shift in the relative productivity of differing sectors. While there is ample evidence of an ongoing and substantial difference between the average productivity *levels* of the Japanese export manufacturing sector and of the rest of the economy (discussed at more length later), there is no evidence of a *change* in those relative levels in the 1990s, or an abrupt shift in any Japanese sector's competitiveness versus the rest of the world. As seen in Table 4.7, the difference between average annual TFP growth rates in the manufacturing and nonmanufacturing sectors in the 1990s (2.1 percent) fell between the difference seen in the 1980s (1.6 percent) and in the 1970s (3.1 percent), and this was not the first decade in which nonmanufacturing productivity stagnated.

Returning to the fundamentals of growth as seen in the Solow growth model, extended by later endogenous growth researchers, provides

[11] See the discussion of the importance of cyclical factors in the upswing in productivity in the United States in chapter 3.

TABLE 4.7
Factor Analysis of Growth Rate of Real GDP of Japan

	Average annual growth rate (national accounts data)			
	1960s	*1970s*	*1980s*	*1990–7*
All industries				
Capital stock	6.9	3.8	2.8	1.9
Labor supply	0.4	0	0.4	−0.3
TFP	2.7	1	1.4	0.2
GDP growth (total)	10	4.8	4.6	1.8
Manufacturing				
Capital stock	7.2	2.7	2.1	0.5
Labor supply	1.4	−0.5	0.6	−1.2
TFP	5.9	3.1	2.4	2
GDP growth (total)	14.4	5.2	5.1	1.2
Nonmanufacturing				
Capital stock	6.4	4.5	3.3	2.3
Labor supply	0.2	0.2	0.3	−0.1
TFP	2.2	0	0.8	−0.1
GDP growth (total)	8.8	4.6	4.4	2.1

Source: MITI, *White Paper on International Trade* (1998).

the necessary perspective on stories of Japanese decline. In the recent literature on economic growth, such factors as initial GDP per capita (as a measure of convergence), schooling and life expectancy of workers (as proxies for human capital), national savings, rule of law and democracy (as measures of respect for property rights), and inflation and government consumption (as distortions or discouragements of investment) are significant predictors of countries' growth rates. Writing in 1996, the noted free market economist Robert Barro predicted a 3.2 percent annual real per capita growth rate for Japan for 1996–2000, on the basis of his main cross-sectional panel estimates, and Japan's high initial scores, on these growth fundamentals.[12]

Although such a result might lead one to be skeptical of the practical utility of the current state of economic growth research, it underlines just how difficult it is to say that Japan has bad, let alone declining, "fundamentals" for growth. The combined Solow and endogenous growth models take into account the supply of physical capital, of human capital (i.e., the quality adjusted supply of labor), the starting level of technology, the state of government, and the social structure. Since economic growth is composed of capital inputs, labor inputs, and technological progress, this would seem to about cover it.[13] Writing a few years later, and with the benefit of a few more years data, Hartnett and Higgins (2000) still find that Japan scores high on all of these except government policy (see Table 4.9). The particular government policy measures which they identify, however, include monetary policy and the organization of the central bank, hardly deep structures (and ones on which Japan has shifted noticeably since April 1998).

The OECD has correctly emphasized the ability of structural reform, particularly in the financial, retail, and utilities sectors, to raise Japan's long-term growth rate (e.g., OECD, 1998b), much as it has advocated liberalization for many other countries. Noting this opportunity for efficiency gains, however, does not explain why the same Japanese financial system did not appear to be a binding constraint on Japan's

[12] See Barro (1997). His forecasts had a 2 percent (two standard deviation) margin of error; the U.S. forecast was almost that much below Japan's, and Japan's exceeded almost all other OECD forecasts.

[13] There is some popular concern that Japanese demographics are working against growth, with the world's most rapidly aging population. While this is of course literally true, given that growth in labor supply is one of the components of economic growth, it should not be a focus of this discussion. For one thing, there are a number of currently untapped resources for Japanese labor (such as underemployment of women, and relatively early retirement ages given high life expectancies), as well as possibilities for allowing guest workers or limited immigration, which could rapidly respond to any labor constraint. Another issue is that from the point of view of economic welfare, our concern is with per capita real income growth, which is actually usually enhanced by a declining population. In any event, for the period ten years prior and ten years after the present day, Japanese net population growth is projected to be effectively zero, so talking about changes in aggregate growth and in per capita income growth are equivalent.

TABLE 4.8
Comparative Rates of Growth and Productivity Growth

		1973–9	*1979–89*	*1989–94*
Comparative annual growth rate (Wolff, 1999: Table 1, Panel II)[a]				
Japan	GDP	3.33	4	2.11
	TFP	0.72	1.79	0.91
	Labor productivity	3.35	3.45	2.81
United States	GDP	2.28	2.68	1.82
	TFP	− 0.21	0.47	0.57
	Labor productivity	0.12	0.68	0.98
Germany	GDP	2.45	1.87	2.47
	TFP	2.24	1.19	1.66
	Labor productivity	3.72	2.1	2.77

Comparative labor productivity growth (average percentage annual change in output/employee; OECD, 2000a)

	1980–90	*1990–5*	*1995–8*
Japan	2.8	0.9	0.9
United States	1.2	1.2	2.1
Germany	1.9	2.4	1.9

Comparative TFP growth rates (average percentage annual change in multifactor productivity; Gust and Marquez, 2000)

	1990–5	*1996–9*
Japan	1.31	0.85
United States	0.79	1.47
Germany	1.02	1.07

[a] GDP in 1990 U.S.$; capital is gross fixed private investment; West German data in all periods.

higher growth rate in the 1950–89 period.[14] In other words, the closer one looks at the 1990s in Japan, the more it becomes apparent that although the macroeconomic performance declined sharply and persistently, the causes were limited to the demand side and macroeconomic and financial policy mistakes.

The costliest recession in an advanced economy since 1950 does not indicate a long-term, structural decline in potential output—let alone technological regress. If it did, the output gap in Japan would be rapidly closing as growth has picked up to around 2.0 percent in 1999–2000, but instead unemployment continues to rise, wages and prices continue to fall, and capacity remains unused, all of which indicates the opposite (see Table 4.10).[15] There is no obvious evidence of a structural break from the Japan that put up stellar macroeconomic performance in the 1970s and 1980s, and historically unprecedented growth

[14] Weinstein and Yafeh (1998) convincingly argue that Japan succeeded in the post-war decades despite the drag of an inefficient "Main Bank system," and Hoshi and Kashyap (2001) provide a great deal of evidence on the development of Japanese corporate finance consistent with this view. While improvements in the Japanese financial system are sufficient to improve growth, they are not necessary to do so, and therefore lack of such improvements cannot be to blame for the Japanese growth slowdown (except in the different sense that a mismanaged financial crisis had high costs, which is not a statement about potential growth).

TABLE 4.9
Current Capital and Labor Fundamentals for Growth

	Private investment	*Gross FDI inflow*	*Stock market capitalization*	*Average corporate tax rate*	*Labor growth*	*Secondary school (percent)*	*Tertiary school (percent)*	*Life expectancy*
Japan	28.8	0.04	107.5	34.5	−0.3	100	43	80.3
United States	17.9	1.77	265.3	40	0.9	96	81	77.4
Germany	21	0.53	60.8	53	−0.2	95	47	77.8
Korea	32.9	0.78	75.8	28	1.1	100	68	73.5
Singapore	35.1	9	216.4	26	0.7	76	39	78.1

Source: Hartnett and Higgins (2000).
Notes: Columns 1–3 are as a percentage of GDP; investment and FDI are 1995–8 averages; stock market capitalization and corporate tax rate are 1999; labor growth is 1998–2000 average; school enrollment percentages are 1997; life expectancy is 1998.

TABLE 4.10
Labor Statistics 1985–99

	1985	*1990*	*1995*	*1996*	*1997*	*1998*	*1999*
Unemployment rate	2.6	2.1	3.2	3.4	3.4	4.1	4.7
Age 20–24	4.1	3.7	5.7	6.1	6.2	7.1	8.4
Men 60–64	7	5.1	7.5	8.5	8.3	10	10.2
Employment rate (male)	81	81.1	81.9	82.1	82.4	81.6	81
Employment rate (female)	53	55.7	56.5	56.8	57.5	57.2	56.7
Real wage index	89.9	100	103.2	104.9	105.3	103.1	102.4

Source: Ministry of Labor, *Handbook of Labor Statistics.*

prior to catching up and urbanizing in the 1950s and 1960s, once technological convergence and the transition to a modern economy are controlled for. This raises important puzzles about the relationship between technological innovation and economic growth in the Japanese context.

[15] It should be noted that an average of thirty-eight different predictions of Japan's long-term potential growth rate compiled in 1999 by the high-level Prime Minister's Committee for Strategic Economic Priorities was 2.1 percent per annum (see *Nihon Keizai Saisei eno Senryaku (The Strategy for Reviving the Japanese Economy)*, 1999), not much changed from a few years before. Meanwhile, both the OECD and the Bank of Japan have recently downgraded their estimates of Japanese potential, to 1.25 percent and 1.0 percent, respectively. Posen (2001) offers an argument for why potential growth actually rose in Japan in 1998–2000, and some explanation for why alternative methods might come to the opposite conclusion.

4.3. Independence of Macroeconomic Performance from Innovation Inputs?[16]

4.3.1. Clarifying the Image of the Japanese National Innovation System

The Japanese system of innovation and economic development had become the stuff of legend by the time that Japanese national income per capita approached American levels at the end of the 1980s. The vast literature which emerged to study it, on both sides of the Pacific, identified several key attributes of the system, many of which were exaggerated

[16] The distinction made between "inputs" to innovation in this section, and "outputs" in the next, is based on distinguishing between institutional frameworks that determine which R&D activities get pursued, and the amount of innovative products and processes that come out of these activities.

in the more popular press. Goto and Odagiri (1993, 1997) give the mainstream list of the major characteristics that can be documented. The primary emphasis of the Japanese system is on continuous improvement of production processes as well as of products in publicly identified important or strategic industries, of which steel, automobiles, and electronics were the most notable. Creation of wholly new products or lines of business was not considered to be a primary goal (although more entrepreneurship did arise than is often credited; Johnstone, 1999). This improvement in the selected industries generally began with the importation of key technologies from abroad and the setting of ambitious industrial standards by the Japanese government and industry.[17]

The approach never amounted to "picking winners" of specific companies by the powerful Ministry of International Trade and Industry (MITI) or other agencies in the sense that American observers sometimes believed. Both government contracts and trade protection were employed at early stages of development in a few chosen sectors to provide a minimum market size, but usually for a number of domestic companies. MITI would encourage, with some limited public seed money, joint research and development efforts among those invited companies. Personnel management within these companies and the Japanese educational system encouraged the training of broadly qualified engineers (rather than specialized research scientists), and the seniority system with lifetime employment emphasized the retention and transmission of specialized skills relevant to the company's products. The movement of these engineers between line production and management encouraged their bringing of incremental practical improvements into corporate awareness and eventual company-wide implementation.[18] In the words of the National Industrial Technology Strategy Development Commission set-up by the Japanese government:

> Until recently, Japanese enterprises achieved and maintained competitiveness by introducing basic industrial technologies from Western nations to achieve "process innovation" (i.e., technically enhancing manufacturing processes), which dramatically upgraded productivity and product quality. Underlying this success were uniform standards of education, high workforce morale, long-term investment in human resources, and teamwork between manufacturing employees and management. In short, Japan made full use of the strengths of Japanese society and Japanese business management systems.
>
> (National Industrial Technology Strategy Development Committee, 1999: 8)

These practices on the part of government and industry to promote innovation easily coexisted with the more general principles of corporate organization in Japan: relationship financing of corporations through long-term bank lending, "lifetime" employment for many workers and limited labor mobility for all workers (with the attendant pros and cons), flexible shop floor teamwork and just-in-time inventory, widespread government regulation limiting entry and exit of businesses from various sectors, and primacy of insider stakeholder relationships over transparent accounting and shareholder value. From the perspective of the United States in 2000, for most observers these would all sound like disadvantages (with the exception of worker teams and just-in-time inventory, whose adoption is seen as contributing to the rise in U.S. productivity); what is important is that these broader characteristics of Japanese industry were just as prevalent in the glory years of 1950–80 as they have been in the 1990s.[19]

[17] Lee and Kantwell (1998) argue that (mostly domestic) two-way interaction between user firms and Japanese capital goods producers fed innovation through integration and specialization.

[18] Nonaka and Takeuchi (1995) claim that it is as much tacit knowledge within an organization as explicit, and therefore appropriable, knowledge which gives corporations creativity. Procedures and manuals only take one so far in producing new technologies, but Japanese companies also benefit from workers with broad internal experience that cumulates by transmission, and results in innovation.

What has recently come to light about the post-war Japanese innovation system is the degree to which *domestic competition* among firms in high-tech sectors occurred and even was encouraged, despite the status quo biases of the system. Individual entrepreneurship, while hardly encouraged, was a also significant factor in Japanese technological development. For example, Fransman (1999) documents the start of what he calls "controlled competition" in the electronics and telecommunications industry in the efforts of the Imperial Ministry of Communications in the 1920s and 1930s to have multiple, albeit chosen, suppliers for Japan's developing telecomms infrastructure (as opposed to the United States' de facto monopoly for Western Electric). The big four Japanese electronics and telecomms companies of today (NEC, Hitachi, Toshiba, and Oki) trace their roots to the late nineteenth century, but really were the result of mergers, the entry and exit of foreign joint ventures (with Siemens and Western Electric, for example), and shifting government contracts from the telephone monopoly NTT.[20]

The history of the Japanese automobile industry, home to some of the world's greatest production innovations, is one of great competition, of corporate entry and exit and re-entry, and of individual inventors and entrepreneurs, despite government activism to develop auto production. Ten domestic firms tried to get into the auto business before the end of the 1920s, and failed, with only the government-supported (through Army purchases) Dat staying in, and still Ford and General Motors dominated the Japanese market.[21] In 1932, the predecessor of MITI urged three specific companies to begin new efforts, resulting in the survival of one firm (Isuzu), and several not sponsored by MITI also emerged. Toyota Motors, funded by Toyota Looms, began as a small scale non-zaibatsu firm responding to a risk-taking entrepreneur's vision, without government support. After 1950, both Honda and Suzuki became major automotive producers after their individual owners branched out from motorcycles, and did so without any public-sector encouragement (let alone foreign exchange credits to purchase technology, or government procurement contracts). Meanwhile, Daihatsu eventually was acquired by Toyota in an example of competitive mergers. Mitsubishi Motors entered and re-entered the Japanese automobile market repeatedly as both a government favorite and a member of a major keiretsu family, and still failed to gain a leading domestic market share, let alone a major piece of the export market.[22]

What probably left the greatest impression on outside observers of the Japanese government picking winners in technologies and companies, were the attempts of MITI to create coordinated research efforts in the electronics industry, backstopped by trade policy. The perceived success of the efforts in the cases of the Japanese mainframe computer industry and of the development of very-large scale integrated circuits (VLSI) technology gave rise to the calls in the United States for the Sematech and HDTV government-led research programs (which themselves eventually were deemed failures).

Even in these instances, however, the reality was less coordinated and government directed than the common perception. As Nakayama et

[19] Hoshi and Kashyap (2001) make an interesting historical argument that what they call "Keiretsu financing," the Main Bank relationship financing of industry, was a post-war creation.

[20] In his introduction, Fransman (1999: 14) cites approvingly an apparently self-translated passage from a 1994 Japanese language research volume on "The Industrial Policy of Japan" which reads: "All of participants in this [multi-author] project recognized that, excluding the brief period immediately after the end of the war, the foundation of rapid growth was competition operating through the price mechanism and a flourishing entrepreneurial spirit. In opposition to the 'Japan, Inc.' thesis, it can even be said that the history of industrial policy in the principal post-war periods (in particular the 1950s and 1960s) has often been that the initiative and vitality of the private sector undermined the plans of government authorities to try to utilize direct intervention in the nature of 'controls.'"

[21] See Goto and Odagiri (1993).

[22] Michael Porter's discussion of Japan in *The Competitive Advantage of Nations* gives additional anecdotal evidence about the importance of domestic competition to Japanese technical progress and performance, arguing that Japan's export success only came as a result of this competition.

al. (1999) describe, in the early 1960s, Japan had six players in the computer industry, all but one of which were partnered with a U.S. firm. The innovative IBM System 360 and System 370 mainframe computers wiped out the competition in both the United States and Japan. The MITI Computer Systems Project of 1966–72 to build a Japanese competitor or successor to the 360 did not function as planned. "[S]kepticism pervaded the engineering staffs from the [six selected] competing companies. It often happened in national projects like this that MITI's endorsement was used to persuade corporate management to support in-house R&D, but technological exchange among [participating] companies was minimal."[23] Eventually Fujitsu and Toshiba emerged as viable competitors to IBM in the computer hardware market, but three of the other six firms participating in the project got out of the computer business entirely, while a fourth stayed in only with the support of government purchases and never was an innovative player.

Japanese firms did come to dominate the market for RAM and other integrated circuits on semiconductor chips in the 1990s, although control of the microprocessor market went back to the U.S. producers, Intel, Motorola, and others, by the mid-1990s (and most RAM chip production moved offshore from Japan).[24] This dominance is often attributed to the success of MITI's VLSI Project of 1976–80, based on the forecast that 1 megabit memory chips for general purpose computers would be a key electronics market segment. Even within the "Research Association" framework, MITI pursued a relatively decentralized course. Three laboratories (Computer Lab, NEC-Toshiba Information Systems Lab, and the VLSI Joint Lab) were set up, with the participation of an initial five companies (and a couple more added later). The brief of the joint work was to emphasize fundamentals, which in practice meant a focus on lofty far off projects (like the development of electron beam equipment). The truly practical next generation technologies, like photolithography methods for etching circuits on chips, were tightly held within the participating companies. In fact, the biggest impact may have been on those Japanese companies, like Canon and Nikon, which were not directly involved in the VLSI Project, but received demanding requisitions for equipment to create inputs (like aligners for circuits).

In any event, this was to be MITI's last major success of this kind in the electronics industry (at least to date).[25] There were smaller Research Association-type projects pursued since 1980, but "difficult[ies] arose for MITI with the diversification of the electronics technology, the maturation of Japanese industry, and the uncertainty of emerging technologies." (Nakayama et al., 1999: 47). The trend of government subsidies for private R&D research was already on a downwards trend from 1960 through 1980, further indicating that the end of these projects was not a major difference between the Japanese innovation system of today and the recent past.[26] Writing in 1993, when the Japanese system was still believed to be a model, Goto and Odagiri gave a very measured description of industrial policy's role in promoting R&D:

> [F]or MITI, Research Associations have been a convenient way to distribute its subsidies to promote the technologies MITI (and particular firms) believed important, most notably semiconductors

[23] Nakayama et al. (1999: 44).

[24] See chapter 10 on innovation in the semiconductor industry.

[25] The "Fifth Generation Computer Project" which MITI started in 1981 as the next new technological goal was shut down a few years later with no visible results

[26] Only a miniscule share of government spending in Japan is spent on industrial policy, let alone on promotion of innovation. The vast bulk of public spending is on keeping dead sectors like agriculture and rural construction firms alive (and Diet members from the LDP re-elected). The waste of public funds on redundant or useless infrastructure projects cannot be exaggerated (see Posen, 1998), but also cannot be called in any way a subsidy of technical innovation—the way some defense spending in the United States can.

> and computers, and have been used to avoid favoring particular firms and to minimize the cost of supervising the use of subsidies. From this viewpoint, it is not surprising that only two of the 87 associations had [actual] joint research facilities; in all other cases, each member firm simply took its share of research funds and carried out the research in its own laboratory. Therefore, how coordinated the research really was among particular firms within each Research Association is doubtful except for a few cases. The effectiveness of these Research Associations in generating new technologies is also doubtful … Research Associations' productivity as measured by the number of patents divided by its R&D expenditures was considerably lower than that of [private] industries …."
>
> (Goto and Odagiri, 1993: 88)

Moreover, even in electronics, individual entrepreneurship played at least as great a role as government intervention in the development of Japanese capabilities. Throughout most of its rise, Toshiba had been an outsider as far as NTT's procurement went, not becoming a member of the telephone monopoly's equipment provider "family" until NTT's privatization in 1985; Fujitsu only entered and stayed in the computer industry due to the efforts of a strong corporate chairman overruling the concerns of his upper management and board. Johnstone (1999) gives numerous examples of individual Japanese electronics entrepreneurs, not all that far removed from the garages of Hewlett and Packard, or Jobs and Wozniak (although probably more crowded). As Johnstone documents, numerous Japanese physicists working in the electronics industry undertook their own trans-Pacific exchanges and education efforts, and created both innovations and companies. The paradigmatic example is, of course, Sony, which began life as Tokyo Telecommunications Research Laboratories, with twenty employees in May 1946. Starting with a small contract for recording equipment from NHK, and inspired by visits to the United States in the early 1950s, Sony's two founders built the largest consumer electronics company in the world. Sony was one of many companies worldwide to license Western Electric's transistor technology in 1953, but was the only one to gamble on creating transistor radios (which required the innovation of phosphorus doping the transistor to get reception in the radio frequency range).[27]

One important exception to the general characterization of the Japanese national innovation system as largely unchanged in the 1990s, and as less interventionist (and more competitive) than usually thought, may be the area of trade protection. By all appearances, Japan did engage in some rather aggressive infant industry protections and export promotion policies for autos, computers, and other domestic industries. And whatever the intent behind earlier barriers, there is no question that Japanese trade protection has declined in recent years through a combination of international trade agreements and U.S. pressures. It is possible that while Japanese industrial policy may not have succeeded in directing innovation or picking winners consistently, earlier industrial policy efforts might still have given benefits by granting sufficient scale to exporters of manufactured goods.

The more careful evidence, however, points in the other direction. Lawrence and Weinstein (1999) show rather conclusively in a multi-year panel of industries that trade protection interfered with sectoral TFP growth in Japan (and Korea). Imports had a salutary effect on TFP in those Japanese industries where they were allowed in, with the resulting increase in competition and learning significantly feeding innovation as long as Japan was behind the technological frontier. In other words, trade protection did not nurture internationally competitive firms in Japan in the pre-1973 period, imports did. Meanwhile, Lawrence and Weinstein show that export success by industry is significantly correlated with productivity gains, not with protection or other industrial policy measures. It is still possible that economies of scale could

[27] In fact, MITI refused to give Sony the foreign exchange credits for the license, and Sony had to come up with the money on its own.

emerge in a virtuous circle with high export growth. The key is that controlling for protection by industry or firm takes away nothing from the explanatory power.

This result is consistent with the experiences of the auto and electronics industries, those being the two most important and successful Japanese export industries, and clearly industries who developed by importing technology and facing competition. So even if the Japanese government's ability to engage in trade protection and export subsidization has declined in the 1990s versus earlier decades, that shift cannot be the source of a negative change in the national innovation system because the most innovative sectors (as measured by TFP growth) were the industries which were not subject to these policies.[28] Thus, in terms of the Japanese institutional framework for supporting innovation, the first puzzle of declining macroeconomic performance, despite unchanging innovative inputs, holds.

4.3.2. Measurable Innovation Inputs Also Remain Steady

The description of the unchanging framework of the Japanese national innovation system only takes us so far. Thinking in terms of the measurable building blocks for innovation—funds devoted to research and development, supply of technically skilled workers, communications and educational infrastructure, private sector leadership in R&D allocation—allows us to also track whether Japan has kept the same innovation framework, but dedicated fewer resources to it, or used those resources in more wasteful ways. A drop off in innovation inputs prior to the economic downturn of the 1990s might help to explain the decline in growth, or a cutback in the funding and promotion of R&D as the downturn took hold might explain the persistence of slow growth. This remains plausible, although its importance must be limited given the aggregate level evidence outlined in the first section on why technical regress appears to be inconsistent with recent developments.

The measured inputs to innovation in Japan, however, appear to have remained steady between the 1980s and the 1990s, along with the framework for utilizing them. Japan's rate of R&D investment, as a percentage of GDP, has consistently been higher than that of Germany or the United States, running 2.80 percent on average from 1987 to 1997 (see Table 4.1, and the more detailed year by year comparisons given in chapter 1). In other forms of research and development infrastructure, such as the number of internet hosts or personal computers per capita, Japan does lag behind the United States (see Table 4.11)—but that should be consistent with a rise in the American growth rate (through IT capital deepening) in the most recent years, not a decline in the Japanese one. Germany which lags similarly behind the United States on these metrics saw its trend growth rate undiminished, although the relative growth gap widened. If "internet readiness" of the broader citizenry is the issue, the much higher Japanese use of mobile phones per capita—many of which now add wireless internet services in Japan—should at least partially compensate for the lower level of PC usage.

Japanese R&D funding, especially private corporate R&D funding, has continued to grow in the 1990s, even as total private investment has fluctuated, and for the most part steeply declined. As seen in the third panel of Table 4.12, which shows the year-over-year percentage changes, both total and private sector R&D investment declined somewhat in 1993 and 1994, immediately following the hit of the bubble's burst, but grew strongly over the next

[28] Some earlier papers by David Weinstein and co-authors, on domestic industrial policy and on the Japanese financial system, advance the argument that the Japanese economy grew despite counterproductive government interventions implemented during the high growth years, as Lawrence and Weinstein (1999) conclude with regard to trade protection specifically. Posen (1998: chapter 6) takes much the same "success despite" view of the earlier periods of Japanese development, but also extends a similar argument to the Japanese decline in the 1990s, concluding that the decline was largely caused by new mistaken policies, not by long-standing institutions that were present through times good and bad. See also McKinsey (2000: 1), "Surprisingly, we found that the Japanese economy was never as strong as it appeared to be during its glory days. In fact, today's woeful economic performance is not so much a reversal of fortune as a revelation of the holdovers of Japan's success in the 1980s."

TABLE 4.11
Current Technological Fundamentals for Growth

	R&D expenditure	*Internet hosts per 10,000*	*PCs per 1,000*	*Mobile phones per 1,000*	*Nobel prizes per capita*
Japan	2.8	163.75	237.2	374	0.032
United States	2.63	1508.77	458.6	256	0.703
Germany	2.41	173.96	304.7	170	0.329
Korea	2.82	55.53	156.8	302	0
Singapore	1.13	322.3	458.4	346	0

Source: Hartnett and Higgins (2000).
Notes: R&D expenditure is average percentage of GDP, 1987–97; Internet hosts is 1999; PCs and phones is 1998; Nobel prizes is per million population as of 1999.

four years. R&D funding in the public and university sectors was hit harder initially and responded more weakly, but showed a similar upwards J-curve. A far greater share of Japanese R&D is funded by the private sector than in the United States, despite the fact that the total share (in GDP) of R&D investment is consistently higher in Japan than in the United States. This differential is of long-standing, and not merely the reflection of the lack of defense spending in Japan. This bears out the picture of MITI and other government sponsored "research associations" playing a relatively small role in the encouragement and direction of Japanese innovation versus the role played by private corporations given above.

Considering the comparative distribution of R&D funds in the G3, Japan and the United States are actually reasonably similar in their relative weightings of basic versus applied research, with German R&D funding being more oriented towards basic research than either of the others (see Table 4.13, as well as the discussion of the biases of German research networks in chapter 5). Interestingly, research conducted in the Japanese university system tends to put a lower emphasis on basic research relative to applied engineering than in the United States or Germany. This is not a necessary result of the greater public (including defense) funding of research in the United States, since the larger share of self-funded private research in Japan could just as easily have freed up the universities to pursue more academic projects. What is clear is that in both source of funds and orientation of their use, Japanese R&D has been at least as focused on practical private-sector industrial problems as German or American R&D.[29]

What makes this bias towards private funding, and towards applied research even in universities, particularly odd for Japan, is the absence of a patenting or licensing framework for universities to get revenues from inventions, or for universities and companies to set up partnerships. Such profitable registrations and relationships have been common in the United States, especially since the passage of the Bayh-Dole Amendment in 1983 reducing the licensing fees and allowing universities to keep revenues from patents developed on government contracts. In Japan, after much discussion, such a law was passed in April 1998, as part of an effort to promote more cooperation between industries and universities. For the purposes of the present discussion, however, the key point is that Japanese R&D funding did not become increasingly diverted from industrial concerns in the 1990s versus the earlier post-war period.

[29] National Research Council (1999) documents that these differences between the United States and Japan in emphasis on basic research, on public versus private R&D funding, and on university–corporate cooperation are of long standing. See also the narrative discussions in Goto and Odagiri (1997), Fransman (1999), and Nakayama et al. (1999), all of which give a similar description of a Japanese R&D focus on very applied engineering problems, even in the universities, to that seen in these numbers.

TABLE 4.12
Research and Development Expenditures 1992–8

Fiscal year	*Total*					*By private firms*						*By public research organization*					*By university*				
	R&D total	*Wages*	*Material*	*Physical stock cash flow*	*Others*	*R&D total [1]+[2]+[4]+[5]*	*Wages [1]*	*Material [2]*	*Physical stock depreci-ation [3]*	*Physical stock cash flow [4]*	*Others [5]*	*R&D total*	*Wages*	*Material*	*Physical stock cash flow*	*Others*	*R&D total*	*Wages*	*Material*	*Physical stock cash flow*	*Others*
100 million yen (current prices)																					
1992	137091	63575	21471	19108	32938	90536	39620	16928	9194	10254	23734	18968	5973	2844	4835	5316	27587	17982	1698	4019	3888
1993	135960	64990	21620	17061	32290	89803	40224	16805	8756	9343	23430	18632	6148	3115	4522	4847	27526	18617	1700	3195	4013
1994	144082	67199	23042	19706	34136	93959	41672	17912	8674	10135	24239	20302	6319	3261	5216	5506	29822	19208	1869	4354	4391
1995	149022	68649	25483	18642	36248	98813	42529	20072	8625	10508	25702	20078	6470	3549	3935	6124	30131	19650	1861	4198	4422
1996	150793	69875	25604	18683	36631	100584	43755	20194	8673	10550	26085	20078	6470	3549	3935	6124	30131	19650	1861	4198	4422
1997	157415	72094	26948	18972	39401	106584	45329	21107	8968	11571	28577	20239	6617	3890	3444	6289	30592	20148	1951	3957	4536
1998	161399	74160	26500	19383	41356	108001	46654	20891	11185	10648	29808	21170	6821	3545	4072	6732	32229	20685	2064	4664	4816
Share (percent)																					
1992	100.0	46.4	15.7	13.9	24.0	100.0	43.8	18.7	–	11.3	26.2	100.0	31.5	15.0	25.5	28.0	100.0	65.2	6.2	14.6	14.1
1993	100.0	47.8	15.9	12.5	23.7	100.0	44.8	18.7	–	10.4	26.1	100.0	33.0	16.7	24.3	26.0	100.0	67.6	6.2	11.6	14.6
1994	100.0	46.6	16.0	13.7	23.7	100.0	44.4	19.1	–	10.8	25.8	100.0	31.1	16.1	25.7	27.1	100.0	64.4	6.3	14.6	14.7
1995	100.0	46.3	17.0	12.4	24.3	100.0	43.5	20.1	–	10.5	25.9	100.0	32.2	17.7	19.6	30.5	100.0	65.2	6.2	13.9	14.7
1996	100.0	45.8	17.1	12.1	25.0	100.0	42.5	19.8	–	10.9	26.8	100.0	32.7	19.2	17.0	31.1	100.0	65.9	6.4	12.9	14.8
1997	100.0	45.9	16.4	12.0	25.6	100.0	43.2	19.3	–	9.9	27.6	100.0	32.2	16.7	19.2	31.8	100.0	64.2	6.4	14.5	14.9
1998																					
Year to year change (percent)																					
1992																					
1993	−1.4	1.9	−7.5	−2.2	−3.1	−5.3	0.9	−10.0	−1.8	−17.6	−5.4	7.0	2.9	−0.1	27.0	0.9	7.1	3.9	9.1	22.5	7.2
1994	−0.8	2.2	0.7	−10.7	−2.0	−0.8	1.5	−0.7	−4.8	−8.9	−1.3	−1.8	2.9	9.5	−6.5	−8.8	−0.2	3.5	0.1	−20.5	3.2
1995	6.0	3.4	6.6	15.5	5.7	4.6	3.6	6.6	−0.9	8.5	3.5	9.0	2.8	4.7	15.4	13.6	8.3	3.2	10.0	36.3	9.4
1996	3.4	2.2	10.6	−5.4	6.2	5.2	2.1	12.1	−0.6	3.7	6.0	−1.1	2.4	8.8	−24.6	11.2	1.0	2.3	−0.4	−3.6	0.7
1997	4.4	3.2	5.2	1.5	7.6	6.0	3.6	4.5	3.4	9.7	9.6	0.8	2.3	9.6	−12.5	2.7	1.5	2.5	4.8	−5.7	2.6
1998	2.5	2.9	−1.7	2.2	5.0	1.3	2.9	−1.0	24.7	−8.0	4.3	4.6	3.1	−8.9	18.2	7.1	5.4	2.7	5.8	17.9	6.2

Source: MITI via author's communication.

TABLE 4.13
Comparative Allocation of R&D Funds

	Total			*Industrial*			*University*		
	Basic	*Applied*	*Develop-ment*	*Basic*	*Applied*	*Develop-ment*	*Basic*	*Applied*	*Develop-ment*
Japan	15	24.6	60.5	6.8	22.2	71.1	54.2	37.1	8.7
United States	17.3	23.2	59.5	5.9	22	72.2	67.1	25.2	7.6
Germany	21		79	5.7		94.3	73.4		26.6

Source: MITI, *White Paper on International Trade* (1997).
Notes: Japan data are FY94, United States data are FY95, Germany data are FY91; German data do not distinguish between "Applied" and "Development".

If any change had occurred, it would have only pushed Japanese R&D further in what we would today consider the right direction of private funding and applied usefulness.

A similar point can be made about Japan's patent laws more generally. The extent of patent protection for innovators is a critical component in the willingness of companies to undertake large and risky investments needed for technological progress. In the post-war period, patent protection in Japan has been relatively weak as compared to American standards (although certainly much stronger than in most of the rest of Asia, and than in some other OECD countries). In Japan, patent applications are made public within 18 months of filing, allowing competitors to copy and reverse engineer, even though the granting of patent rights can take years longer. The pendency period is only seven years, and the legal code puts a narrower scope on the claims owners can make about what their invention covers. Since the Uruguay Round of trade negotiations concluded in 1994, Japanese patent protection was extended to twenty years, English language applications for Japanese patents deemed acceptable, and the Japanese patent model has converged on international norms.[30] As in other aspects of the Japanese innovation system, on this measure of patent rights, Japan exhibited little variation over the periods of high and low performance, and what change occurred was in what would be considered the constructive direction.

Even taking into account the large gross amount of finance provided for R&D in Japan, and the fact that it is largely provided by private-sector sources, the efficiency of the way that capital gets allocated to specific projects, and whether that changed over time, is still an open question. Of particular concern is the flow of funds to newer firms and start-ups. Although there have been examples of important businesses arising from individual or partnerships of entrepreneurs in post-war Japan, such as Sony and Honda, most observers of the Japanese economy have expressed concern about the willingness of the "Main Bank system" of Japan to shuttle funds to small and medium enterprises (SMEs). SMEs unaffiliated with supplier networks to larger firms, let alone keiretsu, are thought to be often shut out, even though such independents are probably the source of many innovative advances. And like almost every other developed economy, the culture and practice of venture capital in Japan is thought to exhibit far less vitality than in the United States.

The flip side of who gets the finance is how borrowing firms get monitored in their activities. The OECD (1995) analysis of *National Systems for Financing Innovation* gives a good description of the widely perceived differences between American-style "short-termism" and a Japanese or continental European "corporate governance" on both sides of the allocation/

[30] The acceptance of English language patent applications is doubly important – of course, it eases the ability of foreigners to make claims for patent protection of their innovations in Japan, but it also eases the process of application for most scientists, given the use of English as the language of work in most technical fields.

monitoring coin.[31] The Japanese monitoring approach was held to have the benefit of maintaining funding through a firm's temporary liquidity problems, because involved stakeholding lenders are more able to see the actual promise of current investments beyond current cash-flow; it was also hoped that the relationship banking approach would preclude some excessive risk taking on the part of borrowing firms, in which those firms funded largely by (collateral and monitor free) equity might engage.[32] These claimed advantages were not only offset by the putative lending biases against new entrants, listed above, but also the difficulties of firms making a liquid exit when needed from a web of cross-shareholdings and large scale lending, where merger activity was largely absent.

In practice, the system of corporate finance in Japan is the aspect of the Japanese economic system to have undergone the most profound—although still partial—transformation in the last twenty years.[33] Interestingly, it has been mostly in the direction of greater liberalization and securitization, starting with a round of deregulation in 1984–6, which has allowed major nonfinancial firms to issue bonds and commercial paper (rather than to depend upon banks), and given a broader range of companies better access to capital markets. Between 1984 and 1990, the share of bonds in corporate liabilities doubled (from 4 to 8 percent), while the amount of bank lending remained stable at around 60 percent (see Table 4.14). This aggregate picture of the corporate sector masks an enormous distributional shift, with the biggest corporations radically cutting back their dependence on bank loans, and hundreds of nonkeiretsu affiliated SMEs getting new access to bank credit on the basis of land collateral rather than evaluation of credit worthiness (OECD, 1995; Shimizu, 2000).

TABLE 4.14
Financial Liabilities of Japanese Non-Financial Corporations (percentage shares, some categories omitted)

Year	*Bank loans*	*Bonds*
1980	56.5	3.4
1981	57.1	3.5
1982	59.5	3.8
1983	59.6	3.8
1984	59.8	4
1985	62.2	5.4
1986	64	5.8
1987	60.8	6.5
1988	61.8	6.7
1989	61.1	7.8
1990	60.7	8
1991	60.5	8.7
1992	62.1	8.7
1993	62.8	8.3
1994	62.3	8.3
1995	60.8	6.8
1996	59.6	7.4
1997	59.2	8.2

This partial deregulation led to deposit rich banks losing their highest quality corporate borrowers. The banks' diversification of their loan portfolios declined along with average quality as the SMEs all offered the same form of collateral, and similar correlations with the business cycle. With both banks and nonbank enterprises using loans based on land price increases to purchase equities, the partial deregulation of Japanese banks was a major source of the land and stock market bubble of the late 1980s, and was the primary cause of Japan's eventual banking crisis in the 1990s. For the purpose of this chapter's investigations, what is worth noting is that from 1984 until the credit crunch came in 1997 when banks' cost of loanable funds and level of nonperforming

[31] A cautionary reminder is in order, that as late as 1992, the *Harvard Business Review* and MIT's Made In America project, as well as the U.S. Government's Competitiveness Policy Council, were emphasizing the purported advantages of "patient" Japanese corporate finance through bank lending, as opposed to the "short-termism" of American stock market based financing. This was held to be especially true for allowing investment to take a long-term perspective on such matters as research and development.

[32] Aoki and Patrick (1994) make the academic case in favor of the Japanese Main Bank system.

[33] A much more detailed account of the developments summarized in this and the following paragraph can be found in Hoshi and Kashyap (2001) and Mikitani and Posen (2000).

loans rose sharply, availability of credit to new firms rose, and the cost of capital to established firms fell. If anything, there was *over-investment* in capital projects in corporate Japan, right through the mid-1990s when bad loans were repeatedly rolled over (rather than foreclosed and written down) due to moral hazard on the part of below-adequacy or even negatively capitalized banks.[34]

Thus, even though the Japanese bank-based financial system clearly did great harm to the macroeconomy as a whole in the 1990s, and probably was not helpful in prior years,[35] it would seem to have been at least as supportive of *financing innovation* in recent years as it was in the past. Living up to some of the claims made for benefits of a long time-horizon for investment from relationship banking put forward during Japan's heyday, major Japanese corporations sustained the financing of R&D activities throughout even the investment and growth downturns of the 1990s. It is clear that, given the limited share of innovative activities in economic performance, and the costs of rolling-over unproductive investments, on balance such a financial system is a drag on the economy, even if R&D funding is stabilized by it.

Moreover, the experience of the 1990s has demonstrated the continued bias of relationship lenders in the Japanese financial system in favor of those who have already borrowed, and against outsider firms. Even as the pool of those who were on the inside, and able to gain financing, rose in membership and declined in quality from 1984 onwards, the criteria for lending were biased backwards to SMEs with previously accumulated assets (particularly land) and relationships (e.g., as suppliers to established firms). Start-ups with intangible assets and future customers associated with new products or ideas were shut out (in contrast to the venture capital industry and the high price/earnings ratios for new firms in the United States). Thus, there is still potential for missed innovative investment opportunities in Japan, even while overall R&D spending is maintained through economic downturns. Japanese bankruptcy law, which as one would expect puts a great deal of power into the hands of debt holders, and gives strong incentives not to declare bankruptcy, additionally constrains risk-taking behavior by lenders and by potential heads of start-ups.[36]

Japan has consistently had a lower rate of both business start-ups and bankruptcies than the United States, which sets the benchmark for the pace of corporate "creative destruction." From 1981 to 1996, an annual average of 4–5 percent of the total number of business establishments in Japan were started, and a comparable number were closed[37] (Tanaka, 2000); in the United States over the same period, business openings ranged from 13 to 15 percent of the total number of establishments every year, and closures ranged from 11 to 13 percent. Of course, this turnover of business firms in the United States consists mostly of small service and retail sector companies (restaurants, frame shops, contractors), not high-tech start-

[34] Even though aggregate investment did clearly decline in the early 1990s (see Table 4.1), the fact that problem loans were rolled over rather than called for the most part meant that capital losses were not recognized at the borrowing firms, and so their investments did not decline anywhere near as much as they should have. Moreover, because the largest firms had already largely left the banking system for their major financing needs, and the application of tighter lending standards/bank recapitalization has only been extended to part of the Japanese banking system, SMEs have been the major recipients of this largess.

[35] Why else would so many strong nonfinancial firms, when given the opportunity to exit banking relationships in the mid-1980s, have done so? Why else would so many SMEs take advantage of new opportunities to borrow if they had not been credit constrained in the past? See Hoshi et al. (1990) and Weinstein and Yafeh (1998).

[36] Among the more off-putting aspects of Japanese bankruptcy law are that: creditors holding more than 10 percent of equity can declare for the firm, on the condition that the creditors believe the debtors will be unable to pay; there is only limited relief from creditors during reorganization, and no official receiver is appointed until the reorganization is complete; and the scope of the debtors' assets protected from confiscation is very narrow, limited to clothing, furniture, and other everyday items.

[37] Table 4.6 shows the growth rates in these numbers, with bankruptcies increasing faster than start-ups in both the 1980s and 1990s.

TABLE 4.15
Comparative Venture Capital: Japan and United States (1996 data)

	Japan	*United States*	*Percentage Japan/United States*
Outside sources of new venture funding (percent)[a]			
Pension funds	0	40	
Endowments	0	20	
Domestic corporations	26	18	
Financial sector	49	5	
Individuals	1	8	
Overseas investors	4	2	
Venture funding (percent) by stage (years from founding)			
<1	2	5	
1–5	20	46	
6–10	20	32	
11–20 (Japan), 11–15 (United States)	25	12	
21+ (Japan), 16+ (United States)	32	5	
Overall venture capital environment (1996 data)			
Venture capital companies	165	699	24
Annual total investment	¥231 billion	$10 billion	21 (at ¥109/U.S.$)
Total new established	¥105.5 billion	$6.6 billion	15
Newly public companies	168	755	22 (at ¥109/U.S.$)
Total companies on OTCs	752	5568	14

Source: Weitzman (1999).
[a] Does not sum to 100 percent due to missing responses.

ups and failures, and similarly for Japan. So a steady rise in the amount of firms being allowed to exit from the Japanese business sector is probably a healthy development for the economy as a whole.[38] For innovation, the question is how many risky bets get backed to start up, even if that is a small proportion of total new businesses.

As already mentioned, the Japanese venture capital situation is far less developed than that of the United States. In 1996, for example, 75 percent of the outside funding for new ventures came from the banking system or other established companies in Japan and none from pension funds or endowment investors, while in the United States 60 percent came from those latter two sources (the more traditional angels of equity) and only 23 percent came from established corporations or banks (see Table 4.15). A survey in 1999 by Japan's National Life Finance Corporation found that family, friends, and relatives provided 42 percent of the total initial finance for start-ups, and financial firms and established corporations 35 percent (i.e., 57 percent of the outside funding). As seen in the second and third panels of Table 4.15, the Japanese venture capital sector, in addition to playing a smaller role, also tends to get in much later in a

[38] "Allowed to exit" is used consciously, given the legal, public, financial, and informal networks which constrain the free entry and exit of businesses from sectors in Japan. Ideally, this would be an impersonal market outcome, not a set of conscious decisions, but that is not yet the case for much of the economy.

company's development (77 percent of funding occurs after five years, versus 49 percent in the United States), and this has resulted in a much smaller number of new firms making it all the way to over-the-counter (OTC) stock market listings (14 percent as many in Japan as in the United States, while the Japanese economy is now less than 40 percent the size of the U.S. economy).

The underdevelopment of venture capital is an acknowledged concern by various Japanese government agencies. The New Business Promotion Department of MITI notes (2000) disapprovingly that in FY1999 the average amount of a given venture capital stake given to a start-up was Yen 45million in Japan, or about U.S.$400,000, while the average stake put up by an American venture capitalist was twelve times as much, or U.S.$4.9 million. This is attributed in part to the absence of pension funds and the like engaging in any investment, or in venture capital specifically in Japan. "If Japan's pension funds invested 2–3% of their total managed assets in venture capital investments on par with the U.S. situation in the 1980s, it would create Yen 5trillion [about 1% of a year's GDP] in venture capital, or five to six times more than the total amount of outstanding venture capital funds [in Japan] today."[39] While this emphasizes the sense of innovative opportunities missed by the Japanese financial system, it again raises an issue which cannot be said to have changed for the worse as a prelude to or concurrent with the slowdown in the 1990s, or makes Japan noticeably different from other OECD economies. On the availability of venture capital, it is the United States which is a (positive) outlier.

The final measurable input into the previously described Japanese national innovation system is that of labor and human capital. This is the one area where it could be argued that the quantity of a necessary factor in the production of innovation, in this case, of appropriately skilled labor, has declined in the 1990s. Japanese primary and secondary education remains of high quality and essentially universal.[40] The number of students going on to higher education has risen in recent years, rising from 36.1 percent in 1987 to 47.3 percent in 1997, a ratio comparable to that in the United States; graduate education, however, lags behind with the number of graduate students in Japan amounting to only 6.6 percent of the number of undergraduates, as opposed to 13.2 percent in the United States.[41]

Turning specifically to training for technological innovation, the Japanese university system curriculum in science and engineering is consistent with its use of R&D funds, described above; very applied studies are given relative weight over training in basic science, but connections with the private-sector are scarce. This is also the mirror image of most science and engineering education in the United States. In fact, private industry's funding of university research almost completely stopped in the 1970s, and the government took active steps to encourage its limited revival in the 1990s (many Japanese scholars and students jealously observed Japanese businesses' funding of research laboratories and university programs in U.S. science and engineering schools).

Perhaps as a result, the old system of each professor as an autonomous unit (*koza*) has survived, which keeps graduate students and junior faculty as disciples for long periods, and encourages incremental progress on the full professor's oft-lagging ongoing research agenda (Nakayama et al., 1999). Faculty members are recruited for the top schools from within, with no value put (and probably some sanction) on outside work or consulting experience in the private sector, while the lower

[39] New Business Development (2000).

[40] In 1997, 96.8 percent of Japanese students aged fifteen and older went on to (three-year) high school, and were taught the rigorous nationally approved curriculum. It is beyond the scope of this essay to consider whether the common portrayal of Japanese education as rigid, emphasizing memorization and conformity, and stifling creativity holds true, and how much this detracts from the wide range of knowledge conveyed to students.

[41] Ministry of Education, Science, Sports and Culture data from *Comparison of International Educational Indices* (Japanese data are from 1995, U.S. data are from 1992).

tier schools tend to hire faculty from the higher ranking universities when they retire.[42]

It is therefore no wonder that most Japanese firms believe they have to offer a year or more of "relevant" training after hiring to even Masters of Engineering graduates. Meanwhile, given the age profile of the faculty, the lack of corporate relationships, and the status quo bias, it should come as no surprise that the Japanese universities are significantly behind their American counterparts (and the Japanese private sector) in working on new IT technologies. The University of Tokyo, the nation's most prestigious school of higher education, does not even have an IT department, and MITI projects a shortage of 200,000 information/computer technology engineers in the coming years.[43]

Of course, the U.S. education system has also left the American economy short of skilled engineers and scientists, and the government has responded to business demands by increasing the number of immigration visas for such workers to the hundreds of thousands per year. Japan has begun down that road, but the number of foreign engineers in Japan in 1999 totaled only 15,700 (up from only 3,400 in 1991). It is in the area of skilled labor that Japan's innovation inputs may indeed be falling short in the 1990s, although this should still further explain the inability to keep up with U.S. advances rather than a decline of innovation (unless we believe IT innovation to be the only field where major advances can be made at present). The ongoing lack of both skilled and unskilled labor inputs, likely to worsen as Japan gets older, is a constraint on high-technology production as well as on the economy as a whole. Of course, greater utilization of women in the Japanese work force, and the raising of the retirement age for already very long-lived and healthy Japanese workers, could combine with increased immigration or guest-workers to address this shortfall.

4.4. Independence of Innovation Outputs from Macroeconomic Performance

The relationship between technological innovation and national economic performance is likely to be a two-way street. While most of the traffic goes from advancements in technology and productivity to growth, there is also some flow in the other direction from growth providing the environment and resources for innovation. In the case of Japan, we have already seen that the national innovation system and more measurable innovation inputs were essentially unchanged over the period of Japan's rapid post-war growth from the 1960s to the mid-1980s, the bubble economy period of 1985–90, and even after the persistent economic slowdown of the 1990s. If we believe that variations in national economic performance are tightly tied to changes in technological innovation, over time-spans as short as business cycles, this is a disturbing result. Of course, inputs are just that, inputs, and what generates changes in productivity are innovation *outputs*, such as actual patents, high-value-added exports, and technological leadership in advanced industries. Perhaps a close association between innovation and performance in the Japanese post-war experience, including the reversal of economic performance in the last decade, can be found in the quality and quantity of Japanese innovation.

There is a plausible case to be made that although the Japanese national innovation system was largely unchanged in its structures, practices, and inputs from the 1950s through the 1990s, the world and technology changed around it, making the same system less effective at producing innovation in the 1990s. The assessment of the declining relevance of technical higher education in Japan given in the previous section bears some resemblance to this view. This interpretation that the technological world is moving past Japan could be the

[42] This cascade of older professors is recognized and encouraged by the differing retirement ages for faculty across universities. University of Tokyo and Tokyo Institute of Technology at the top have a retirement age of sixty, the remaining quality public universities have a retirement age of sixty-three, and the private universities have a retirement age of seventy or more.

[43] "Japan finds the powerhouse empty of skilled IT workers," Michiyo Nakamoto and Alexandra Harney, *Financial Times*, August 10 (2000: 12).

case even if the assessment of the previous section is correct, that the Japanese system permitted far more competition, with far less research coordination and picking winners, than often thought. Such a mismatch hypothesis could be true even if all of the major changes that occurred in the Japanese innovation system would have to be classified as improvements in encouraging innovation. The mismatch between Japanese economic organization and the global technology shift (to the creativity required for software and biotech, for example) would simply have to outweigh these positive factors. Such an explanation would of course allow the decline in Japanese national economic performance in the 1990s to be attributed, at least in part, to technical change after all.

This position was partly advanced by Lincoln (1988) for Japanese industrial and commercial practices more broadly, not specifically innovation, in his argument that a mature—meaning wealthy and technologically "caught-up"—Japan, having exhausted foreign technology, would have to adapt its structures to remain within acceptable political bounds on trade competition and still grow. In terms of economic analysis of growth rates, however, this argument would seem to imply that Japan should have slowed down more than the average estimated effect of convergence which occurs to all countries as they approach the technological frontier and the accumulation of advanced levels of human and physical capital, and this was not the case.[44] The declines in TFP growth of Japan throughout the post-war period seen in Tables 4.7 and 4.8 are in line with what growth economics would predict, or if anything *lower* than one would expect based on convergence.[45] This would also seem to imply that the Japanese rate of innovation should have abruptly declined upon losing easy targets for reverse or improvement engineering, which we will examine.

The idea that the unchanged Japanese innovation system no longer works given current changes in the pace or nature of technology has also been asserted more pointedly in recent years specifically with regard to technical development, although in much looser form than Lincoln. For examples among responsible observers inside and outside Japan, see OECD (1998b), "More generally, weak business performance has led some to question the appropriateness of the Japanese corporate system in an environment which requires rapid decision-making and calculated risk-taking to achieve higher rates of return." MITI's *White Papers on International Trade* of 1998–2000 call for structural reform to converge on the U.S. model because of the gap with the United States in ICT, software, and biotechnology; and the NITSDC (1999) states, "The targets of technological innovation were clear enough in the catch-up years when Japan was achieving rapid economic growth due to increased demand. [As opposed to the present,] such targets as building a product image concept or fulfilling requirements specified were easy to identify." The popular business press is, of course, filled with strong claims that Japan is not entrepreneurial or flexible or creative enough to take advantage of new industries like those in information technology fueling the U.S. boom, because they require start-ups and lack of conformity. Again, if these assertions were true, the measurable innovative inputs marshaled by the unchanged Japanese innovation system should be of declining value, and the measurable outputs in terms of technologies and competitiveness should decline as a result.

Data are readily available on whether innovation outputs of technologies and competitive

[44] Specifically, this would mean that using the sort of cross-country panel estimated by Barro discussed in the first section to make a prediction about growth rates, controlling for other fundamentals as well as convergence (proxied by initial per capita income), Japanese growth would come in below predicted levels starting sometime in the late 1970s or early 1980s. Japan, however, remained a positive outlier in such growth regressions until the 1990s.

[45] One could also point out that the Japanese growth rate actually speeded up for several years in the mid-1980s, Japanese income levels approached American levels, and when growth slowed, it was as Japanese income levels have declined in relative terms throughout the last decade. Even such multiyear swings are probably best seen as too short-term to be determined by convergence issues, which is precisely the point against the simple catch-up hypotheses.

TABLE 4.16
Comparative Shares of Academic Research

	Percentage share of world articles[a]	*Percentage share of world citations*[a]	*Academic papers*[b] *(× 10,000)*		*Academic citations*[b] *(× 10,000)*		*Quality ratio: citations/papers*[b]	
			1986	*1996*	*1986*	*1996*	*1986*	*1996*
Japan	9.6	8	7.7	9.9	6.6	7.8	0.86	0.79
United States	36.2	52.3	37.5	34.6	54.6	51.6	1.45	1.49
Germany	8.1	9.2	7.8	8.5	6.6	9.9	0.85	1.16

[a] *Source:* Science Citation Index Database, computed in MITI (1997), 1994 data.
[b] *Source:* OECD (1998: Table 33).

industries are declining in Japan during the period of Japanese economic decline. Turning first to measures of the academic research produced in the sciences, Japan, of course, does continue to lag behind the United States in the capture of Nobel Prizes (see Table 4.11), and does not produce the amount of academic papers or citations proportional to its share of world population or wealth. As seen in the first panel of Table 4.16, Japan and Germany have essentially equivalent shares of articles and citations listed in the Science Citation Index (SCI) database for a representative sample year (1994), despite the German economy and population being two-thirds the size of Japan's, and the United States has several-fold more articles and citations.[46] This is a statement about comparative levels, however, not about whether Japan's share has suffered a sustained decline in recent years, and there is no evidence of that.

The second panel of Table 4.16 presents OECD (1998) data taken from the SCI in 1986 and 1996. The gap between the U.S. and Japanese number of papers published, and the number of total citations to published articles, actually closes over the decade, and in absolute terms both the number of refereed published technical papers by Japanese authors, and the number of citations to Japanese authors rises (by 22 percent and 18 percent, respectively). It must be noted that Japan's "quality ratio" (defined as number of citations per paper) declines slightly (by 8 percent) over the decade, while the American quality ratio is essentially unchanged. So despite the concerns about the basic research capabilities of Japan as the global cutting edge technologies shifted in the 1990s, there is no evidence of a sharp decline, rather some of an improvement.

Turning to actual patents applied for and received, the evidence is also that Japanese innovation has kept up with the times. As noted previously, the 1994 Uruguay Round of the GATT led to some standardization of patent protection and procedures across countries, as well as some specific changes in the Japanese framework. This makes longitudinal comparison of data before and after 1993 somewhat problematic, but makes easier the comparison of developments across countries since that time.[47] What can be seen is that Japan has in recent years had the lion's share of patent and utility model applications worldwide. In 1997, for example, Japan filed 9.4 percent of the world's patent applications, versus 5.2 percent for the United States and 4.3 percent for

[46] The SCI article and publication numbers, while the best available measure, inherently understate the actual contributions of Japanese researchers because many publish some or all of their work in Japanese, which of course limits their outlets and readership (as might publishing in English as a second language, for a given quality of research). There is unfortunately no way of estimating the size of this effect.

[47] Additionally, in 1987 Japan changed its "model application" for patent protection, revising the multiple claim system which previously obtained, resulting in a steady increase in the number of patents applied for within Japan since 1988. This, too, makes analysis of the long-term pattern of Japanese patent data problematic.

Germany.[48] Of patent rights owned worldwide in 1997, the United States held 1,113,000, Japan held 871,000, and Germany held 337,000. Unlike academic papers, Japan carries a share of patents much larger than its proportionate share (as compared to the United States or to the world total) based on population and wealth. The U.S. National Research Council/Japan Society for the Promotion of Science joint task force (1999) observed that basic research conducted by Japanese corporations has been undiminished through the 1990s, while corporate basic research has actually declined in the United States. Another indication in line with the discussion under inputs, that Japan's system does maintain long-term investment, and that even if that has predictably positive effects on innovation, those do not necessarily outweigh other factors on growth (including some potentially harmful ones directly from low returns on capital).

In line with Japan's on-going production of patentable technologies, the country's balance of technology trade has improved over time. Up until the mid-1970s, Japanese firms were heavily dependent upon technological imports from the United States and Europe. As Japanese private sector R&D activities increased in the late 1970s and the 1980s, technological exports increased, first to the developed economies, and in the 1990s increasingly to affiliates or operations of Japanese multinationals in the emerging Asia. As MITI (1998) notes, the value of Japanese technological imports from Western countries remained steady in the 1990s—Japan's overall technology trade deficit has ranged between 1 and 4 percent of GDP since 1980, with no pattern of expansion in the last 10 years. This would appear to be inconsistent with a world in which new technologies emerged outside Japan that were of particularly high value added, such that Japanese firms would be incapable of producing the goods (at least in part) themselves, or of finding other technologically advanced goods to trade for them. It is an undeniable reality that Japan has shortfalls in the production of ICT, software, and related services, especially as compared to the United States, but these are not the only high-tech goods in the world.[49] Even if investment in these technologies may have special spillover benefits for growth, that is a matter of the economy as a whole adopting them, and *not of producing* those products themselves. In other words, the willingness of the Japanese economy to do necessary capital deepening as new transformative technologies arise is likely to be independent of whether Japan has the technical capacity to produce high-tech goods; this point is discussed further in the next section.

In fact, according to the U.S. Patent and Trademark Office, the five fields generating the most patents annually since 1995 are active solid-state technologies, optics, computerized control systems, semiconductor manufacturing processes, and pharmaceuticals. Japanese companies are among the world leaders in the first four of these, and nearly control the markets for optical and active solid-state technologies.[50] In the last five years, patents granted to Japanese inventors and corporations have averaged 19 percent of the total annual patents granted by the U.S. Patent and Trademark Office, twice the proportion of twenty years

[48] Policy Planning and Research Office (2000), from WIPO and MITI data. Annual patent and utility applications from Japan consistently stay within the range of 39,000–46,000 per year.

[49] "Japan continues to import technologies from Europe and the United States in the fields of telecommunications and electronics, and, while relying less than before on foreign sources for hardware, depends increasingly on foreign software … Looking at service industries, Japan ranks first in service trade deficit among major countries, and is weak in international competitiveness owing to low service export intensity." (MITI, 1998: 14).

[50] In Fransman's (1999) assessment of the ICT industries, "four out of the world's top ten computer companies are Japanese (Fujitsu, NEC, Hitachi, Toshiba); two out of the top ten telecommunications equipment firms are Japanese (NEC and Fujitsu); and six out of the top ten semiconductor companies are Japanese (NEC, Toshiba, Hitachi, Fujitsu, Misubishi Electric, and Matsushita) … [these firms] dominated global markets in areas such as memory, semiconductors, optoelectronic semiconductors, microcontrollers and LCDs … [they have been] significantly less successful outside Japan in crucial markets such as mainframe computers, workstations, servers, personal computers, microprocessors, packaged software, and complex telecommunications equipment."

TABLE 4.17
Leading Companies in Total U.S. Patents

	Rank in total new patents granted in that year				
	1999	*1998*	*1997*	*1996*	*1995*
IBM	1	1	1	1	1
NEC	2	3	3	4	4
Canon	3	2	2	2	2
Samsung	4	6	16	18	21
Sony	5	5	9	9	11
Toshiba	6	8	8	7	6
Fujitsu	7	7	5	8	12
Motorola	8	4	4	3	3
Lucent	9	13	11	34	na
Mitsubishi Electric	10	11	7	6	5

Source: U.S. Patent and Trademark Office.
Note: Japanese firms are shown in bold typeface.

ago.[51] As shown in Table 4.17, six of the top ten patenting companies with the U.S. Patent and Trademark Office in 1999 were Japanese, and every one of those six had been in the top ten either four or all five out of the five years 1995–9. The *Business Week* "Info Tech 200" list for 2000 puts 148 of the world's top ICT companies in the United States, while Japan has only 17 which make the list – but that 17 is good enough for second place in the national statistics, with Canada (5), Taiwan (5), and Sweden (3) rounding out the top five locations. Again, this is difficult to reconcile with a belief that recent technological advances have left Japan behind, or that a mature Japanese economy is incapable of advancing the technical frontier. That these years coincided with the worst macroeconomic performance by the Japanese economy since 1950 is an especially striking indication of the apparent independence of Japanese innovative outputs from economic performance.[52]

4.5. The Disjuncture between High-tech Innovation and Broader Productivity Trends in Japan

Obviously, the fact that Japan has steady investment in R&D, ongoing success in generating innovation, and competitive high-tech industries has been insufficient to maintain a high level of national economic performance. This could be due to the fact that in the medium-term of even a decade such factors as macroeconomic policy and financial market efficiency, as well as external shocks, predominate in swings of growth.[53] Yet, the importance of technology to economic performance should not be entirely discarded, even for the swing in Japa-

[51] U.S. Patent Trademark Office data cited in "The Alchemy of Innovation," Conrad de Aendle, *International Herald Tribune*, September 23 (2000: 13)

[52] In a provocative empirical paper, Edward Wolff (1999: 12) groups industries by their R&D intensity of production, and by their growth rates, and analyzes whether Japan specialized in the wrong industries as compared to Germany and the United States. He concludes "… that generally speaking [in 1970–1989] Japan's industrial structure moved towards industries experiencing higher growth rates … In the 1989–94 period, by contrast, the overall output growth rate is insensitive to the choice of output weights. This result indicates that the slowdown in aggregate growth over this period is due to the decline of output growth across the full range of industries in Japan, rather than to a shift in output towards slower growth industries.".

[53] Posen (1998: chapter 6) makes an argument to this effect as a warning to premature judging of "national economic models" as determinative of swings in economic growth, let alone as cohesive wholes.

nese growth of the last two decades; it is arguable that the major contribution of innovation to national economic performance is in how it is used and implemented across a national economy, rather than in capturing the benefits of innovation itself.

It is well known that the bulk of the Japanese economy, in fact practically the entire economy outside of the export-oriented manufacturing sectors, is beset by very low productivity, extreme inflexibility, and long-term stagnation (except where government patronage directly increases demand). There has been a complete lack of diffusion of either technical progress or labor productivity from the high-tech sector to the rest of the Japanese economy in the last forty years. This bears some resemblance to the assessment made by Gordon (in chapter 3) that, in the United States in the 1990s, the bulk of the productivity gains were made in the computer equipment industry, and were not seen (as yet) in the rest of the manufacturing sector, let alone the rest of the American economy. It would appear that technical progress can be very localized in its benefits, if the nature of the technology is simply to make production of one product (here, computers) cheaper.

Council of Economic Advisers (2001), however, argues that much of the American "New Economy" was due to the benefits of adoption of IT in sectors outside of IT production because it is a "transformative" technology; just-in-time inventory through computerization, greater tailoring of financial and other business services, more decentralized production schemes for workers, and so on, emerge out of IT usage. That report offers the first rigorous empirical evidence that productivity gains in the American economy in the 1990s can be linked to the diffusion of IT across firms. The argument is far from settled, however, and not only because we must wait to see what productivity gains survive the American downturn beginning in the last quarter of 2000. Cohen et al. (2001) note that many changes in U.S. corporate practices, particularly in dealing with their workforces, defining the boundaries of the firm, and increasing flexibility of production—the same practices which Council of Economic Advisers (2001) point to as critical to U.S. improvements in productivity—began to be adopted in the mid-1980s, timed to observable changes in labor demand, and well before IT investment was large or widespread.

What is relevant for understanding the Japanese experience from this American discussion is that, to whatever one ascribes the U.S. productivity gains, the Japanese economy already had it, at least in part; the efficiencies of production of IT components are in industries where Japanese firms and licensed technologies play a key role; the share, level, and growth of business investment in IT is higher in Japan than in any other advanced nation except the United States;[54] the high performance work organizations, including total quality management and team production, as well as just-in-time inventory were prevalent in Japanese manufacturing, and were a model for U.S. adoption. So it is striking that the overwhelming majority of Japanese economic activity has not benefited from these attributes the way that the American economy has. A persistently dual economy to the degree it exists in Japan is really rather odd.

Even putting aside supposedly transformative technologies like ICT and the internet, the idea that there could be so little spillover benefit or seepage of knowledge about productive practices from the advanced sectors in whatever technology to the rest of the Japanese economy for so long goes against some of our common ideas about technical progress. We usually assume that information or knowledge is nonrival and difficult to completely appropriate, that is, that the original innovator's using it does not constrain my also benefiting from it, and that it is difficult for that innovator to keep the knowledge completely to him-/herself. Put bluntly, patent protection is rarely impervious to efforts at copying, stealing, or reverse engineering of a product, technique, or process. This is especially true for the broader or more organizational innovations, for example, the concept of just-in-time inventory, and the methods for

[54] See Fujitsu Research Institute (1997), OECD (2000), and Tanaka (2000) for data on total IT investment.

implementing it, or the idea of the video cassette recorder, which tend to be quickly emulated by the innovator's competitors.

The usual qualification to this assumption is that what we refer to as development, or the detailed implementation and utilization of the knowledge in a specific product is where the profits really come from. It is true that workers can move from place to place, and learning by doing in one product line or with one client or supplier can spill over to others. It is also true that such things as brand names, client relationships, specialized design, management and especially shop floor skills permit a firm, whether the innovator or a follower, to maintain some property rights. So Toyota can watch manufacturing firms around the world adopt just-in-time inventory and quality circles, but its workers (and the training of them) allow Toyota to garner the benefits of more successfully implementing the same innovations; Sony and Phillips can both create the video recorder, find that every other consumer electronics company has their own competing model within months, and be forced to make their profits from their brand names and additional features or quality, not from coming up with the innovation itself.

For the purposes of this discussion, the key implication is that technological innovations should diffuse, both across borders within the same industry, and across industries within the same country, given sufficient human and financial capital to take advantage of the innovation. This diffusion is part of what lies behind the story of conditional macroeconomic convergence in the Solow growth model, seen in the cross-national evidence. A belief in the power of this diffusion is what underlies the many stories of Japan growing through reverse engineering and conscious "catch-up" with Western products. For an industrial sector to remain technologically backwards within a country that has good universal education, free flow of information, and some minimum mobility of workers and capital, usually some government policy (like public ownership, protection of interest groups from competition, or discrimination) is at work to reduce the incentives to improve productivity.[55]

The Japanese dual economy of forty years and counting—clearly the result of excessive government protection of particular interest groups—illustrates just how powerful such government and social disincentives can be even when more productive practices are literally around the corner. McKinsey Global Institute (2000) goes into painful detail documenting how the tightly controlled distribution network for products, the prevalence of mom-and-pop retail stores, the legal environment preventing the adoption of economies of scale in either distribution or stores, the lack of transparency in pricing for consumers, and the political connections of the small store owners to the Liberal Democratic Party, combine to increase the costs and decrease the efficiency of all purchasing in Japan; and, of course, this has implications for the economy as a whole given that consumption is 65–70 percent of Japanese GDP.[56] Hoshi and Kashyap (2001) document how the "convoy system" for Japanese banks and securities firms on the part of Japanese regulators—a much greater moral-hazard inducing version of "too big to fail"—interacted with connected lending relationships and barriers to competition to induce inefficient financial practices. Even manufacturing for domestic use or in lower-technology products in Japan suffers from over capacity and fragmented production due to lack of competition and a network that supports small companies.

The fact that these disincentives have co-existed with the Japanese national innovation system's success in producing technical progress, the Japanese world-beating export companies in high-tech sectors, and the years of both feast and famine in Japanese national economic performance, demonstrates that technological innovation on its own terms is a

[55] The existence of geographic pockets of backwardness in wealthy societies is another matter.

[56] At the margin there have been some changes in this backwards retail system in recent years, through changes in the retail stores law, the existence of internet shopping, and the creation of some discounters, but these small changes so far have not had much of a discernable impact on the Japanese economy.

TABLE 4.18
Comparative Cost Structure for Business (1997 data; Japan = 100)

	Japan	*United States*	*Germany*	*Korea*	*Singapore*
Energy					
Petroleum	100	67	117	152	53
Industrial power	100	77	81	44	38
Transport					
Railway	100	61	67	24	
Coastal shipping	100	131		40	
Port charges	100	90		47	53
Airfreight (international)	100	55	73	98	80
Telecoms					
Local calls	100	97	155	52	29
Long distance	100	48	65	23	
Real estate					
Commercial development	100	11	24	28	38
Office rental	100	55	52	56	70
Corporation tax					
Effective rate	100	82	100	65	54

far less powerful force in determining the fate of national economies than one might have thought. The regulatory structure of the economy (not specific to technology), along with macroeconomic and financial policy (as argued in the first section), may have much more to do with economic growth over any meaningful time horizon for policy than innovation does.[57] Of course, this assumes that the economy in question is at a sufficient level of development, wealth, popular education, and rule of law to allow innovation to occur where the specific protections do not apply.

In Japan, unfortunately, the specific protections apply to almost the entire nontraded (i.e., without import competition) portion of the economy: services, retail, utilities, transportation, real estate, local construction, and so on. Table 4.18 gives the comparative costs to business in Japan and four other economies, including the United States, for various services or inputs to production. In every activity, with the exception of coastal shipping, American business costs are lower: 23–33 percent lower for energy, 39 percent lower for railway shipping, 45 percent lower for air freight shipping, 52 percent lower for long distance telecommunications, and 89 percent lower for the development of commercial real estate. Germany, Singapore, and South Korea also have meaningfully lower business costs than Japan in just about all of these categories. The high costs in each category represent either a regulation (limiting land uses), or a public monopoly (until recently on petroleum), or a government price support program of some sort (NTT on long distance services by wire) protecting an

[57] These sorts of interest group protecting regulations have not been classified here as an aspect of how the government treats innovation, or as part of a country's capacity to innovate. For one thing, so doing would extend the definition of innovation to be anything to do with productivity increases of any kind, and would erode any significance to the technological aspect. For another, these regulations are not directed against innovation, and their removal would directly enhance growth even if technical innovation halted. Finally, it is almost tautological to point out that protectionism, be it domestic or foreign, inhibits the flow of new technologies.

TABLE 4.19
Diffusion Rate of Personal Computers and Networks (percentage of those surveyed)

	Japan			*United States*		
	Home PC	*Office PC*	*Networks*	*Home PC*	*Office PC*	*Networks*
1994	8.6	11.3	28	36.4	41.1	73
1995	11.1	14.1	35	39.8	46.5	82
1996	14.7	19.8	44	43.4	53.4	86
1997	21.6	27.8	48	47.4	59.1	90

Source: Industrial Policy Bureau (1998).

TABLE 4.20
Share of Information-Related Investment in Private Fixed Capital Investment (percent)

	1993	*1994*	*1995*	*1996*	*1997*	*1998*	*1999*
Japan	16.6	19.6	22.4	24.9	26.4	29.5	34.4
United States	26.8	27.7	29.7	31.9	34.1	37.3	42
Difference	10.2	8.1	7.3	7	7.7	7.8	7.6

Source: Tanaka (2000).
Note: Information-related investment includes medical and scientific equipment.

interest group, and therefore removing the incentive to increase productivity.

Consistent with this view, Agrawal et al. (1996) found that the productivity of capital in Japan is only two-thirds that in the United States, but the income share of capital is the same. This inefficiency can be attributed to Japanese corporate management underutilizing available resources, accepting local sourcing of equipment rather than searching globally, and demanding a relatively low financial return on capital. For services in Japan, the picture is just as bleak. According to estimates from the Economic Planning Agency of Japan, the average price of services has quadrupled since 1970, while the retail value of manufacturing has only gone up by 70 percent. This is related directly to the productivity differential between the two sectors.

Meanwhile, the successful high-tech or high-value-added export companies in Japan, like electronics and automobiles, have shifted production overseas and cut domestic factories and employment, in an ongoing effort to stay competitive with additional productivity gains (Japan Development Bank, 1996). The irony of firms like Sony and Toshiba announcing cost-cutting and restructuring programs in 1998, while the construction industry in Japan continued to add 1000s of workers through the largesse of the Liberal Democratic Party majority in the Japanese Diet, cannot be overstated. Yet, the differential in productivity just keeps growing.

McKinsey Global Institute (2000) found that Japanese exporters in such industries as autos,

TABLE 4.21
Foreign Direct Investment to and from Japan (Yen trillion in fiscal year)

	Inward	*Outward*
1994	0.4	4.3
1995	0.4	5
1996	0.8	5.4
1997	0.7	6.6
1998	1.3	5.2
1999	2.4	7.4
2000 (Jan–Jun)	1.9	na

Source: Ministry of Finance, author's communication.

steel, machine tools, and consumer electronics are still "bettering any and all [international] competitors' productivity by 20%," but those sectors only employ 10 percent of the Japanese workforce (no more than the legendarily unproductive construction sector alone). On McKinsey's (2000) estimates, the remaining 90 percent of the Japanese economy is only half as productive, with such sectors as retail, food processing, home construction, and health care running at around 60 percent of U.S. productivity levels in the same sectors. Even under the pressure of Japan's harshest recession, when real estate, wholesale and retail trade, agriculture and fisheries, finance and insurance, and construction are clearly underperforming, the already weak Japanese stock market, and their industries worldwide (Matsuoka and Calderwood, 1999)—and when the more productive Japanese firms continue to be recognized in financial markets, and to lead by example—there is no diffusion of more productive practices to be seen.

4.6. Conclusion: Accepting the Independence of Technological Innovation and National Economic Performance in the Japanese Case (and Beyond?)

Technological innovation is the ultimate source of any sustained economic growth. One can differentiate between truly revolutionary innovations, such as the steam engine or air conditioning or the transistor, and incremental improvements in production processes or products, such as Toyota's Type G loom or the video recorder or better semiconductor chip inscription.[58] The revolutionary technologies improve our well-being as well as our wealth, and can even alter political systems and the international balance of power; but all technological innovations, even the most minor, contribute to economic growth by enhancing our productivity. As a result of such visible power, there is a temptation to ascribe much of the variation in national economic performance across countries, over time, to differences in national innovation systems. Getting beyond the statements, however, that investment in innovation is good, and that having a society that respects property rights and education helps innovation, to issues of real relevance for economic policy in the industrialized democracies takes a bit more doing.[59]

Judged on its direct results, the Japanese national innovation system must be deemed a success. Over the last half-century, Japan went from being a defeated country with a devastated economy to the world's largest net creditor nation with technological leadership in many advanced industries, as well as in many manufacturing processes. From the late-1970s to the mid-1990s, the Japanese economic model—including its emphasis on R&D and the utilization of technology—was hypothesized, described, and then idealized as an exemplar for emulation.

It turns out that with the benefit of a few more years of hindsight and of academic analysis, the elements of Japanese economic success were not all that mysterious (universal high education, high savings and investment during catch-up, low inflation, commitment to R&D, export orientation in key manufacturing sectors). It also turns out that many of the distinctive aspects of the Japanese model were as much hindrances as help (relationship banking instead of transparent securitized finance, protection of domestic sectors from competition, bureaucratic stewardship of a vast share of household savings). The politics of how this system emerged and held together are not trivial, as can be seen by the difficulties of other emerging markets achieving Japanese income levels despite explicit efforts to emulate the "model"; nevertheless, for our understand-

[58] Mokyr (chapter 2) and Gordon (chapter 3) to some degree debate whether the recent developments in IT and the Internet constitute such a transformative technology or not.

[59] Successful implementation of such policies as universal education and protection of property rights are very real issues in developing countries, but for the industrial democracies constitute no more than appeals to motherhood and apple pie.

ing of the role of technological innovation in national economic performance, the messages are clear.

One important conclusion is that the successful Japanese innovation system was less odd and interventionist than it was often perceived to be by American eyes, and therefore also less puzzling in its reasons for success. A consistently high level of R&D investment, funded and allocated for the most part by the private sector, adequate property rights, and excellent utilization of teamwork and specialized worker training in production, combined with domestic competition in high tech and key manufacturing industries and an insufficiently recognized degree of individual entrepreneurship, led to ongoing innovation. But as the mystery of Japan's ongoing success in innovation strictly defined recedes, other notable aspects of the relationship between Japanese innovation and growth come to the fore.

The swings in Japanese economic growth in the post-war period would be truly puzzling if the relationship between technological innovation and national economic performance were particularly tight. Japan's economic growth rate slowed from seemingly miraculous levels in the 1950s and 1960s, to simply tops among advanced economies in the 1970s and 1980s, to outright stagnation in the 1990s. Through this entire period of wide variation in economic growth, the Japanese national innovation system remained essentially unchanged, with both the institutional framework (including such matters as the role of the private and public sectors in the allocation of R&D funding) and the inputs (such as patent rights and access to credit for innovators) stable or turning slightly more favorably towards innovation in the 1990s.[60] Throughout this entire period of wide variation in economic growth, the outputs of the Japanese innovation system—in terms of scientific research, patents, net trade in technology, and competitiveness in high-tech sectors—remained consistently impressive, and (like the inputs) either unchanged or slightly improved during the downturn of the 1990s. The measurable onwards march of Japanese innovation refutes the circular argument that the reason for Japan's poor economic performance in the 1990s must have been a shortfall in technical progress. In advanced economies, there are factors in performance much more significant than technological innovation.

Clearly, there were and are many severe structural problems affecting most parts of the Japanese economy outside of the most innovative sectors. These problems, mostly due to direct or indirect Japanese government protection of various domestic interest groups from domestic competition, have manifested themselves in the creation of a truly dual economy. There has been little or no diffusion of technological progress or productivity enhancing practices from the 10 percent of the Japanese economy that is export competitive to the 90 percent of the Japanese economy that is not—even while corporations and countries around the world have imported or implemented Japanese advances (think of the transformation of American auto industry work and supply practices). Although there are large parts of the United States and other industrialized nations that display similar backwardness relative to the high-tech sectors, in degree and depth of this disjunction, Japan stands alone among the developed economies.

While the protections that give rise to this division are not themselves directed against technological diffusion per se, and do not appear to directly interfere with technological innovation in Japan, they nonetheless do limit Japan's potential growth rate. It would stretch the meaning of "technological innovation" beyond useful recognition, however, to state that these inefficiencies should be considered failures of Japanese innovation policy just because they constrain productivity growth. Furthermore, the drag on the Japanese economy from these inefficiencies and impediments to markets have a much greater *direct* effect on Japanese economic performance than they do through obstructing the adoption of IT or other innovations. A true and complete liberalization

[60] The one exception being Japanese graduate science and engineering education, where there may have been a change for the worse in recent years, as discussed in section 4.2.

of the Japanese financial, retail, and telecommunications sectors would result in an increase in growth of 3 percent or more a year, according to OECD (1998), a number at least double the 1.0–1.5 percent increase in American productivity in the 1990s (which may not be entirely attributable to IT investment in any event). So it is to some degree misleading to cast the need for performance-enhancing change in Japan as a matter of increasing the receptivity of the economy to adoption of innovation—although, certainly, that would be an additional and worthwhile element of reform.

Of course, there still remains a great deal of room for Japan, as for any country, to improve its capacity for innovation and the diffusion of technical change through targeted reform efforts. As mentioned previously, the state of Japanese university research and education in the sciences is poor, and, as in most countries outside the United States, the institutions for venture capital and a culture of corporate start-ups are undeveloped. Even for an advanced economy which does maintain its position at the technological frontier in international competition, more encouragement of innovation is better. Various groups within the Japanese government and business leadership have grown concerned with their country's lagging behind the United States in such growth industries as information technology and biotechnology, while the emerging markets close the gap in manufacturing efficiency (reflected in Japanese manufacturers' "hollowing out" of domestic production).

The Japanese government's NITSDC (1999) report on "National Industrial Technology Strategies in Japan," for example, lists eight sources of concern: few homegrown technologies; lagging behind in intellectual property rights and standards; few start-ups; increasing difficulty of handing down work techniques in traditional Japanese fashion; differences between the skills of university graduates and those demanded by industry; differences between the research emphases of universities and scientific institutions, and those of industry; "foreign institutional ties" in research; and few "Nobel-prize level results." These clearly are more oriented towards increasing innovation inputs and outputs as defined here, and not with easing the adoption of technology in the rest of Japanese society. This reflects an explicit sense of relative decline on the part of Japanese officials in the ability of Japan to "compete" in the leading industries. On my analysis, however, this may be a misguided priority, not only because Japan actually is doing well on innovation outputs, and not only because bigger gains to economic performance may be found in broader economic reforms, but also because the technologies that will be "leading" or "critical" in years ahead may not necessarily be ones which seem important today or where Japan is not already on the path to competitiveness.[61] Of course, such efforts at improving the Japanese innovation system can only help the Japanese economy—so long as they do not come at the expense of other reforms, and are of benefit to general innovative capacity (not targeted towards achieving goals in specific technologies).

The Government of Japan also has taken the view that lagging in IT and biotechnology marks a relative decline in Japan's innovative capacity. A new "Science and Technology Basic Law" passed in 1995 was intended to encourage collaboration between industry, academia, and government-funded research institutions, to begin reforming universities, to increase the creativity of students, and to increase the flexibility of government relationships with industry. As always in Japanese economic policy, however, a whole series of successor laws and programs with the same stated intention were announced before the first publicized effort was ever implemented, even in part. The most prominent in the area of innovation system reform since 1995 have been:[62]

[61] One need only remember how the U.S. economic bureaucracy saw the American economy as perhaps irretrievably behind the Japanese economy in the "critical" technologies of HDTV and semiconductors in the early 1990s, and took that as a verdict on its national innovation system, only later to find that HDTV was a dead-end and semiconductors had become a commodity product. Meanwhile, Japan has potentially leading technologies in optics and in wireless communications which are emerging today, although those are not acknowledged as criteria for judging the effectiveness of the Japanese innovation system, given the present fashions for biotech and IT.

- the "Science and Technology Basic Plan" of July 1996, supposed to increase the mobility of researchers by investing in postdoctoral scientific training, by enhancing the transfer of patent rights in collaborative university research, and by improving the fairness of evaluation of applications for government research grants;
- a promised increase in government R&D investment of Yen 17 trillion (U.S.$155 billion) over 1997–2002, none of which has been funded as of this writing;
- an "Educational Reform Programme" of August 1997 specifically proposed to reform the universities at both the undergraduate and graduate levels;
- an April 1998 law, actually passed, to emulate the U.S. Bayh-Dole Amendment, reducing the licensing fees for university researchers working on patentable technologies supported government grants;
- an "Action Plan for Economic Structural Reform" from MITI in October 1998, which stressed the goal of creating new industries through measures like enhanced roles for venture capital and OTC stock listings, freer labor mobility and use of outsourcing, increasing IPR protection and joint research, and investments in ICT infrastructure;[63]
- and most recently, on December 1, 2000, the Japanese government announced an "Action Plan for New Economic Growth," which "contains a wide range of policy measures to promote continuing economic reform and deregulation in Japan," including "measures to upgrade the foundation for creative research and development."

As could be expected as the result of a government initiative, these last two "Action Plans" serve many objectives at once. Both combine targeted initiatives "to maximize the utilization of IT and to induce demand and capital investment, especially in IT-related fields …" while also recognizing the more general need to reassess "… the extent to which existing systems have served to redistribute resources from high- to low-productivity sectors …."[64]

Leaving aside the questions of the Japanese government's willingness to implement such plans, it should be noted that the stated impetus for these Japanese government proposals is much the same as concerns expressed in continental Europe, particularly in Germany, in recent years, where no abrupt fall from economic grace comparable to that of Japan in the last decade has occurred. Just as the United States was stimulated to improvement by the relatively better performance of Japan in the 1970s and 1980s, it may be inevitable for democratic market countries to compare their innovation capabilities to those of the contemporary leader in productivity. Thus, if this concern constitutes a recognition that an economy should always try to improve its potential growth rate through improvement of its innovation system, no matter how successful that system has been, this would be as healthy development in Japan as it would be elsewhere.

If, on the other hand, an attempt to precisely replicate the current American innovation system is based on a mistaken assessment that Japan's failure to be a leader in biotech and IT

[62] The Japanese government has announced, and in a few important (but certainly not most) cases implemented, a much broader structural reform agenda for the economy beyond the area of technological innovation. See Tanaka (2000) and Nishiyama (2000) for brief advocatory summaries of this agenda.

[63] "The government will concentrate its efforts on the development of a business environment for fifteen industries expected to grow in the future … At the same time, it will cope with various problems related to 'funds', 'human resources', 'technology', and 'information and telecommunications', all of which are indispensable for fostering new industries." (Industrial Policy Bureau, 1998: 8) The specification of target industries sounds like the old image of picking winners, but given that it is fifteen, and they include such broad areas as "Info and telecomms," "Distribution and logistics," "Environment," "Human resources," and "Aviation and space (civil)", the government's priorities seem not all that confining.

[64] Quotations taken from the overall government Action Plan of 2000 (a complete English language outline of this report can be found at http://www.miti.go.jp/english/index.html); the MITI Action Plan of 1998, which was a precursor to this plan, has similar language and multiple objectives. Interestingly, to stave off the type of cynicism engendered by this list of previous "action plans," the English summary notes that "Almost half of the 260 measures [contained in the Plan] will be carried into effect in one year."

indicates that the Japanese national innovation system is the source of Japanese economic decline, it may be unhealthy. Such an effort could divert economic policy attention from the truly pressing needs of addressing debt deflation and financial fragility in Japan, and of liberalizing the 90 percent of the Japanese economy mired in low productivity. Whether intentionally or not, that would shift the blame for Japanese economic stagnation in the 1990s from the factors that truly deserve it. And the Japanese public would in that case eventually be disappointed by its government putting too great a reliance on a close relationship between technological innovation and national economic performance – one that its own country's post-war experience indicates holds loosely at best when other factors such as macroeconomic policy and financial shocks are taken into account. Even if the true advantages for national economic performance from technical innovation come from how widely and well a country uses technology, rather than simply how much innovation it produces, that would lead Japan to a much broader structural reform agenda to enhance competition and reallocation of productive factors, than one which strictly speaking focuses on the national innovation system. If such wide-ranging liberal reforms were ever enacted in Japan, the benefits to growth would largely be felt directly in the efficiency gains in the sectors in question - although the additional gains from the increased flexibility in adopting new technology would certainly be seen throughout the economy as well.