AXEL BÖRSCH-SUPAN
University of Mannheim
Center for Economic Policy Research
National Bureau of Economic Research

Capital's Contribution to Productivity and the Nature of Competition

PRODUCTIVITY RESEARCH has traditionally focused on labor productivity and treated capital intensity as one of the factors causing different levels of labor productivity.[1] Much less attention has been given to the effi-

This paper is based on research performed during the author's sabbatical year at the McKinsey Global Institute, Washington, D.C., directed by William W. Lewis. Sean Greene was project coordinator. Other team members were Raj Agrawal, Tom Büttgenbach, Steve Findley, Kathryn Huang, Aly Jeddy, and Markus Petry. The team benefited greatly from comments by the project advisory committee members: Ben Friedman, Zvi Griliches, Ted Hall, and Bob Solow. The author benefited from comments by Hans Gersbach, Jens Köke, Ulrich Schlieper, Joachim Winter, and the participants at several workshops and seminars, in particular those at the Brookings conference.

1. The literature on international and intertemporal productivity comparisons is vast. For a recent survey, see Gersbach (1997). Most work measures levels and growth of labor productivity at both the aggregate and the industry level. For manufacturing, van Ark and Pilat (1993) compiled a comprehensive set of productivity figures for Germany, Japan, and the United States based on the industry-of-origin approach; McKinsey Global Institute (1993) and Baily and Gersbach (1995) compiled productivity figures based on factory-gate purchasing power parities. More recent estimates appear in Freudenberg and Ünal-Kesenci (1994, for France and Germany), O'Mahony (1995), and Pilat (1996), which included some service industries. McKinsey Global Institute (1992) and Baily (1993) provide productivity level estimates for selected service industries. Another strand of literature investigates total factor productivity (TFP) growth. The work by Denison (1974, 1985) and Jorgenson, Gollop, and Fraumeni (1987) set up the methodology for TFP growth estimates. Based on this, the volume edited by Jorgenson (1995) and the articles by Dollar and Wolff (1988, 1994) provide a set of recent international TFP growth comparisons.There is much less work on TFP levels. Conrad and Jorgenson (1995) and Jorgenson, Kuroda, and Nishimizu (1987) show aggregate and sectoral TFP

ciency of capital management and purchase decisions. High capital intensity may be not only an implication of high labor costs relative to capital, but also a consequence of wasteful allocation of capital. This paper investigates whether the utilization of installed capital is different across the three largest economies of the world—Germany, Japan, and the United States—and if so, why. It also asks whether the amount of assets needed to produce a particular level of productive capacity differs across these three countries, and if so, what the reasons for the difference might be.

The paper synthesizes research on capital productivity carried out by the McKinsey Global Institute and published in 1996. That study is similar to earlier studies that investigated service sector and manufacturing productivity.[2] Most of the data stem from studies performed by McKinsey industry experts, who visited automotive, electric utility, food processing, retailing, and telecommunications facilities in the three countries. McKinsey Global Institute (1996) provides details on the visits, data collection, and findings. These five sectors include the three most capital-intensive sectors of the economy (telecommunications, electric utilities, and retailing) and cover roughly a quarter of the nonresidential physical capital stock in each of the three nations' markets.

The data obtained from plant visits include plant, company, industry, and market sector data. From these data, the McKinsey team computed measures of labor productivity (output per labor hour) and physical capital productivity (output per unit of capital services). Their ratio yields capital intensity, and their weighted mean, total factor productivity, or TFP.[3] Of these four productivity measures, only two are independent. The measure of overall efficiency is TFP. The second

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levels in Germany, Japan, and the United States up to 1979. Dougherty and Jorgenson (1996) provide TFP-level estimates up to 1989. Capital productivity estimates are implicit in TFP and in studies that address labor productivity together with capital intensity. For instance, Baily and Schultze (1990) and van Ark and Pilat (1993) address the contribution of capital to TFP levels without actually reporting capital productivity levels. Capital productivity levels are explicitly presented in Freudenberg and Ünal-Kesenci (1994) for France and Germany.

2. McKinsey Global Institute (1992, 1993); Baily (1993); Baily and Gersbach (1995).

3. More precisely, TFP is the harmonic mean, weighted by the shares of labor and capital.

measure I focus on is capital productivity. Differences in capital productivity may indicate the result of rational choice given prices and constraints, or the inefficient use of capital. For example, low capital productivity may be a rational choice of a manager who achieves high labor productivity with a large volume of capital because labor is expensive relative to capital. Alternatively, low capital productivity could result from unwise capital investments that do not increase labor productivity. A main thesis of the paper is that relative factor prices explain only part of the higher capital intensities in Germany and Japan compared with the United States. There is some evidence that capital purchasing and management practices in these five industries also decrease capital productivity.

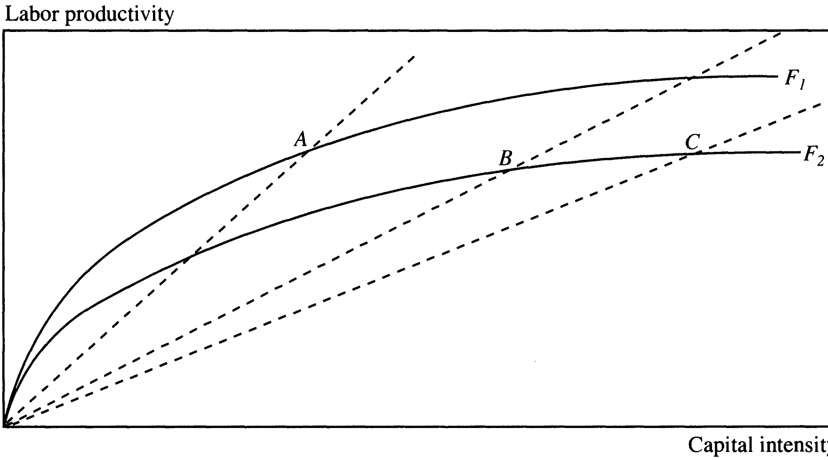
The paper finds strikingly large differences in levels of physical capital productivity across the three economies, both at the macroeconomic level and in the five industries that were studied in detail. In many cases low capital productivity was not offset by high labor productivity. Capital management and purchasing decisions help explain the resulting different levels of total factor productivity in the three economies. Moreover, the differences in capital productivity correlate with the rate of return generated by the corporate sectors in the three economies. The rate of return of the U.S. corporate sector, averaged over the last twenty years, was 170 to 200 basis points higher than the rates of return in Japan and Germany. Such differences have an enormous impact on the increasing share of retirement income that is drawn from pension funds.[4]

The study also shows that the nature of competition facing companies in the product market has strongly influenced the efficiency with which capital is utilized. Specifically, capital markets have reinforced product market competition by cutting off funds to unproductive companies only in the face of competitive threats.[5] Regulation and government ownership were also important causes of low productivity, both directly and indirectly through limitations of competition.

4. According to OECD (1998), about 40 percent of U.S. retirement income is currently drawn from investments on the capital market, including firm pensions, 401(k) plans, and IRAs. See Börsch-Supan (1998) for an analysis.

5. See also Kovenock and Phillips (1997), who provide empirical evidence on the plant level for this interaction.

Figure 1. Capital Productivity, Labor Productivity, Capital Intensity, and TFP



Source: Author's construction; see text for full explanation.

Measurement Framework

The basic economic framework for making productivity comparisons is depicted in figure 1. For simplicity in the arguments below, I assume Cobb-Douglas technologies with identical labor shares.[6] On the axes are output per worker and capital intensity. Capital productivity is represented by a ray through the origin. Technology F_1 (dubbed, "best practice" or, "benchmark") has higher TFP than technology F_2. Industries A and B have adopted best practice with different capital intensities. Industry C represents the case I am particularly interested in: capital intensity is high and capital productivity is low without a compensating increase in labor productivity to bring the industry to top TFP.

Figure 1 also shows the fundamental identification problem in isolating causes of productivity differences. Capital and labor productivity figures do not identify whether it is capital or labor that is managed inefficiently. For example, industry C has both lower capital productivity and lower labor productivity relative to industry B, and there is no

6. A Cobb-Douglas function fits the aggregate data well; see Jorgensen, Gollop, and Fraumeni (1987) or Hall and Jones (forthcoming).

way to tell from the data underlying figure 1 whether it was bad capital management leading to a lower ray through the origin, or bad labor management leading to a lower ordinate value, or a combination of both.

The McKinsey team used microeconomic data to answer this question wherever possible. The team's research strategy was to compare companies that face the same relative prices of labor and capital, the same labor market characteristics (skill levels, costs for overtime, and so forth), but different capital productivity. For example, the team looked for companies that have low utilization rates even though other companies in the same country facing the same wage premiums for shift work run their machines longer. And they searched for instances where companies use structures and equipment of unusually high quality and quantity for a task that other companies perform with fewer assets—even though these companies face the same relative price of capital and similar constraints, such as safety and environmental standards.

In many cases, however, the management of labor and capital is so intrinsically interwoven that there is no point in attributing the corresponding change in TFP to either labor or capital. For example, a better assignment of personnel to machines increases labor and capital productivity simultaneously. Nevertheless, important insights can be gained by looking at capital's side of this joint improvement, mainly because earlier research has focused on labor management aspects, paying less attention to capital management issues. The obvious next question is why managers waste capital or manage capital and labor inefficiently. The paper goes through a checklist of potential explanations, including lack of competition, weak corporate governance, and inefficient government regulation

Data

The paper used data from four levels of aggregation: data at both the plant and company level obtained from interviews and benchmarking studies, published data at the industry level, and data for the entire market sector of each country. A consistent core set of data on output and capital was then constructed at each level of aggregation.

These data are a unique and very rich body of evidence largely untapped by academic research. The representativeness, validity, and replicability of this evidence has been discussed elsewhere.[7] In this particular study, the representativeness of some sectors is an issue. Although interviews and benchmarking studies covered most companies in concentrated sectors (automotive, telecommunications, electric utilities), such coverage was not possible in food processing and retailing. To improve the representativeness of the sample, the interview data on capacity utilization, capital expenditures, pricing, and the like were cross-checked with publicly available data sources such as industry censuses and published industry studies.

Sector Definitions

In contrast to most other studies using aggregate data, the aggregate analysis here is restricted to the market sector of each economy because there is no meaningful aggregate measure of productivity for the nonmarket sector.[8] The excluded nonmarket sector consisted of government, education, and health care services. Obtaining a consistent definition of the market sector and each industry across the three countries is not a straightforward task because sector definitions vary and because the sector definitions for output and capital stock data do not fully overlap in some industries even within a country. In these cases, more disaggregated data had to be used.[9] Nonindustry and auxiliary services, such as equipment production, were excluded from the telecommunications service industry.

Output Data

When meaningful, *physical output* was used—for example, kilowatt-hours (kWh) in electric utilities and call-minutes in the telecommuni-

7. Although many of the industry studies used are public (and quoted in the sources below each exhibit), benchmark studies performed by McKinsey are confidential. See the Comments and Discussion section of the Baily and Gersbach (1995) paper for a discussion of validity and replicability issues related to these data sources.

8. See the chapters by Jorgenson and Fraumeni and by Murray in Griliches (1992) for measurement of output in the education and public sectors, respectively, and Baily and Garber (1997) for an international productivity comparison of treating specific diseases.

9. For details, see McKinsey Global Institute (1996, aggregate analysis, box A1).

cations industry.[10] In the three industries in which output is heterogeneous (automotive, food processing, and retail) and at the market level, *value added* was used as the output measure.[11] Value added was converted into physical units of output by dividing it by sector-specific purchasing power parities (PPPs). The appropriate PPP for productivity comparisons are the unit prices at the factory gate of comparable products across countries.[12] Such an industry PPP was constructed from the bottom up in the automotive industry, weighting individual product PPPs to obtain an average PPP exchange rate for the industry as a whole. In the other industries and in the market sector, the relevant expenditure PPPs for taxes and distribution margins were adjusted to approximate factory-gate PPPs for the corresponding industries. The source for the PPPs was the most recent benchmark comparisons made by the Organization for Economic Cooperation and Development (OECD) in 1990 and 1993; because these benchmarks differed slightly, the 1990 and 1993 PPPs were averaged.[13] Table 1 displays the PPPs used for the large aggregates.

Capital Input Data

Because accounting conventions differ dramatically across countries with no evidence of corresponding differences in service lives, the McKinsey team did not use national accounting figures of capital stocks.[14] Instead, it applied the perpetual inventory method to time

10. Figures were drawn from the manufacturing censuses in the three countries (Germany: Statistisches Bundesamt; Japan: Economic Planning Agency; U.S.: Census of Manufactures).

11. Aggregate and industry data on value added were based on the OECD National Accounts 1981–1996 (OECD 1995, 1997, 1998).

12. There is an extensive body of literature on the usage of PPPs in international productivity comparisons. The methodology is summarized in Pilat (1994). A comparison of several approaches to approximate factory-gate PPPs can be found in Hooper (1996). See also the discussion on the papers by van Ark and Pilat (1993) and Baily and Gersbach (1995).

13. The sectoral results are published in OECD (1992, 1995). The EKS aggregation scheme was applied to the set of three countries to compute sectoral PPPs, for example, from industry to market level. More precisely, the appropriate deflators between 1990 and 1993 were applied to the 1990 benchmark prices to obtain an estimate of the 1993 PPP, and this estimate was averaged with the 1993 PPPs reported by the OECD.

14. See Blades (1991, 1993) for recent surveys of measurement issues. O'Mahony (1993) provides a bibliography on capital stock measurement.

Table 1. Purchasing Power Parities
Relative to 1993 U.S. dollar

		Total economy		*Market sector*	
Country	*Exchange rate*	*Value added*	*Gross fixed capital formation*	*Value added*	*Gross fixed capital formation*
Germany (DM)	1.65	2.10	2.27	2.47	2.38
Japan (Yen)	111	184	213	227	213

Source: Author's calculations based on OECD (1992, 1995).

series of capital expenditures at the industry, market, and total economy levels, subtracting standardized, rather than nationally defined, depreciation. The team did this separately for structures and equipment as well as for each sector. Capital expenditure time series were taken from the U.S. Bureau of Economic Analysis, the Japanese Economic Planning Agency, and the German Statistisches Bundesamt (Volkswirtschaftliche Gesamtrechnungen, Fachserie 18), starting in 1925 or earlier. The value of capital expenditures was converted to physical units by dividing structures by the OECD nonresidential structures PPP, and equipment by a general equipment PPP that was aggregated from the corresponding detailed OECD equipment PPPs.[15] The study used the "sudden death" depreciation schedule, assuming that capital services flows are evenly distributed over the entire life of the capital good. Sector-specific service lives as computed by O'Mahony were used for structures and equipment.[16] TFP and capital productivity differences are insensitive to the choice of depreciation schedule and length of service life as long as they are the same across countries. The methodology follows Maddison and O'Mahony, and the study's net capital stocks are closely comparable to their estimates in the years and sectors where the two sets of data overlap.[17] Table 2 displays the concentration of capital across the five industries studied in this paper.

Capital stocks were also converted to a measure of the *flow of capital services* used in the production process by dividing capital stocks by their service lives. Differences between stock and flow measures are

15. OECD (1992, 1995).

16. O'Mahoney (1993). I am grateful to Mary O'Mahony who provided hitherto unpublished data enabling me to compute capital stocks with a consistent definition of the market sector in each country.

17. Maddison (1987, 1993); O'Mahoney (1993).

Table 2. Capital Breakdown by Industry, 1994
Percentage of market economy

Country	*Automotive*	*Food processing*	*Retailing*	*Telecom-munications*	*Electric utilities*	*Other industries*
United States	1.4	1.4	8.4	4.8	8.2	75.8
Germany	5.1	2.0	4.4	3.9	4.4	80.2
Japan	3.5	1.3	7.4	3.5	6.1	78.2

Source: McKinsey Global Institute (1996, "objectives to approach," exhibit 12).

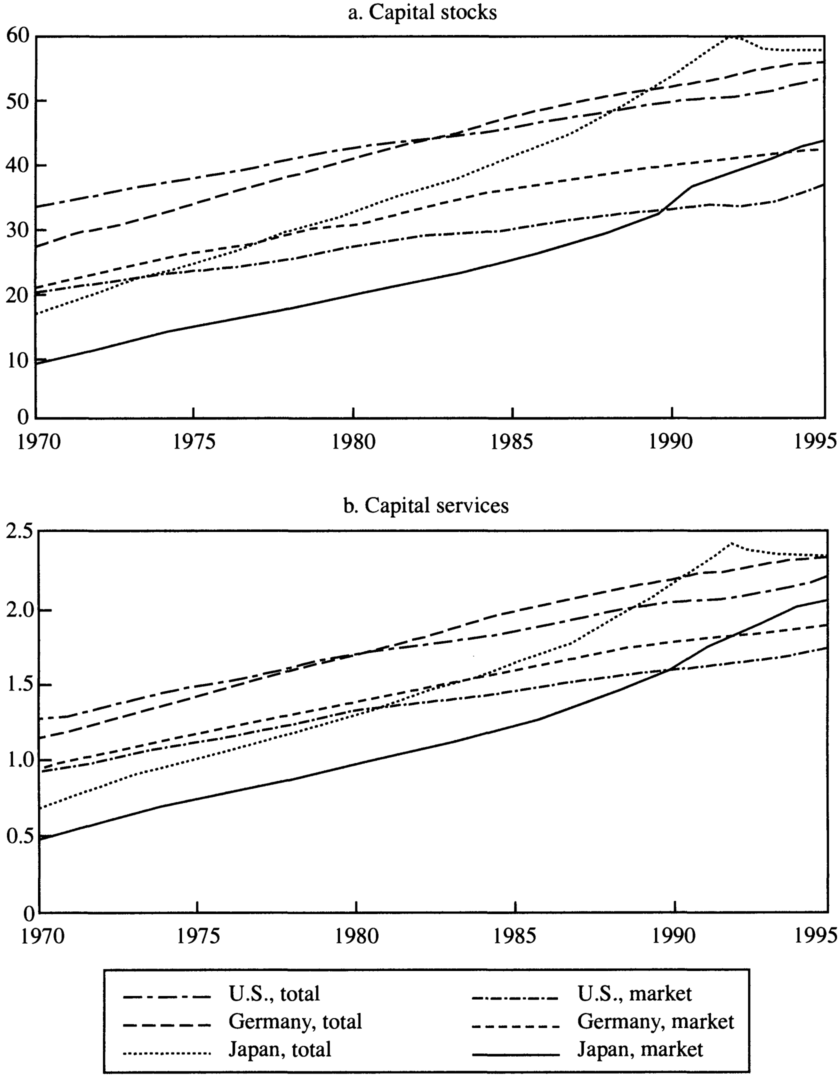
caused by differences in the composition of the capital stock: Germany has the highest share of structures that have a longer service life; Japan the lowest and thus a relatively smaller flow of services than equipment. The McKinsey team believes that service flow, rather than capital stock, is the more appropriate measure of capital usage in production. German flows of capital services in the market sector are closer to the U.S. flows than the corresponding stocks are; the difference is larger between Japan and the United States.

Figure 2 displays capital stocks and services in the total economy and the market sectors of the three countries, measured on a per capita basis. In the market sector, Germany exceeded the U.S. per capita level of capital stocks and services as far back as in 1970. At that time, Japan was at an earlier stage of development and had less than 40 percent of structures and about 50 percent of total capital relative to the United States. Capital grew in all three countries but faster in Germany and Japan. The speed of accumulation was particularly high in Japan during the bubble years of the late 1980s but slowed dramatically afterwards, particularly in the nonmarket sector. The United States increased equipment stocks more quickly than structures, whereas Germany and Japan grew their stocks of structures faster, leading to differing growth rates of stocks and services.

Taking 1992–95 averages, market-sector capital services in Germany and Japan were 10.3 and 16.2 percent higher than in the United States, measured on a per capita basis. During the same time, labor input per capita in the market sector, measured in hours, was 21.7 percent lower in Germany and 37.2 percent higher in Japan. This implies that the flow-based capital intensity was 41 percent higher in Germany and 15 percent lower in Japan than in the U.S. market sector. Total economy capital intensities are closer to each other. In 1992–95, flow-based

Figure 2. Capital Stocks and Services Per Capita, 1970–95

Thousands of 1993 U.S. dollars[a]



Sources: McKinsey Global Institute (1996, 1997, 1998) and author's calculations.
a. Measured at gross fixed capital formation PPP.

Table 3. Productivity Results
Percentages relative to U.S. = 100

Country	*Automotive 1991–93*	*Food processing 1992*	*Retailing 1992*	*Telecom-munications 1994*	*Electric utilities 1993*	*Market economy 1991–95*
Total factor productivity						
Germany	70	65	95	47	73	85
Japan	120	47	55	58	57	59
Capital productivity						
Germany	65	70	110	38	78	68
Japan	100	64	65	46	49	66
Labor productivity						
Germany	75	63	90	72	66	96
Japan	130	39	50	96	101	56

Sources: Author's calculations based on McKinsey Global Institute (1996, 1997, 1998).
Notes: Labor's and capital's shares in TFP vary across industry but not across country.

capital intensity in Germany was 34 percent higher and in Japan 8 percent lower than in the United States.

Results

Table 3 summarizes productivity results for the five sectors studied and for the market economy. Productivity in Japan and Germany is lower than in the United States with two important exceptions: automotive production in Japan, and retail in Germany. In the automotive industry and the market sector, the results are averaged in order to purge business cycle effects. The variation across sectors and countries is large. Most striking is the contrast between the Japanese automotive sector and the other four industries in Japan, notably the food processing sector. German and Japanese TFP and capital productivity are remarkably low in the capital-intensive and highly regulated or monopolized telecommunications and electric utility industries.

The paper proceeds in two steps. First, it studies the market sector results in order to obtain a survey of the general situation in the three countries. It then investigates capital utilization and capital investment decisions in each of the five sectors.

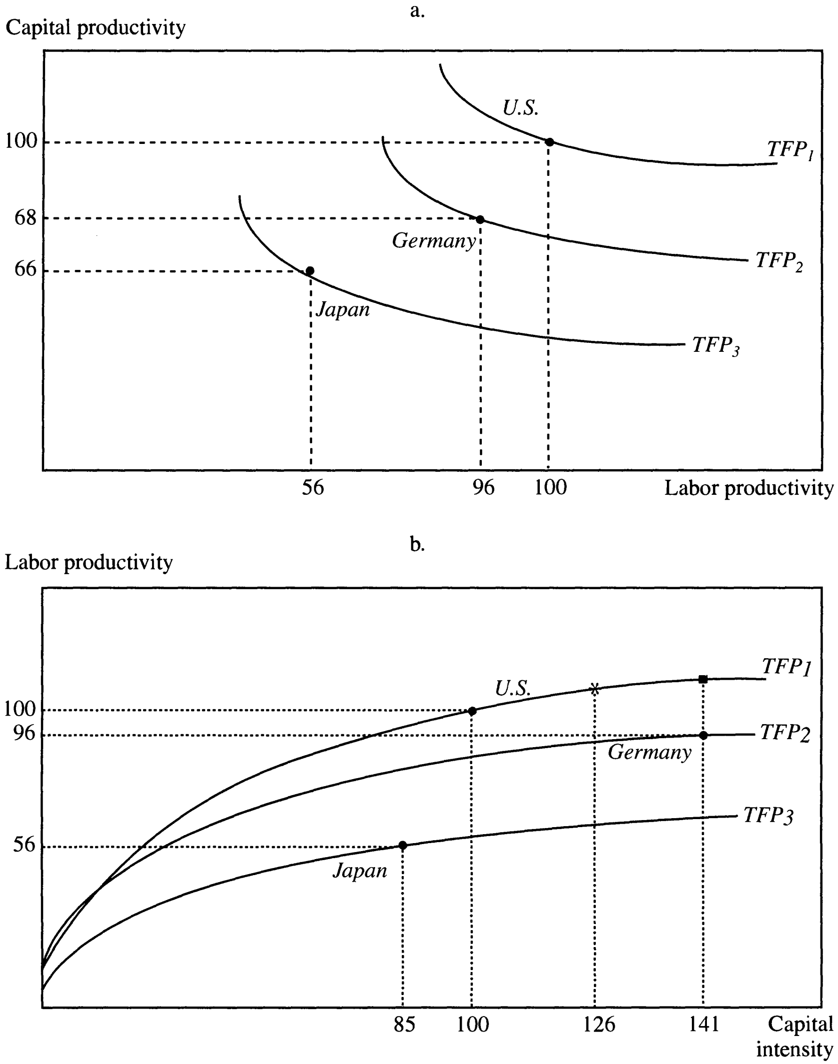
Market Sector

German market sector TFP is 15 percent lower than U.S. TFP. This estimate of the gap is not much different from the estimates that were cited in the introduction, although those estimates referred to the total economy at the end of the 1980s and were based on capital stocks. The 41 percent TFP difference between the Japanese and U.S. market sectors is substantially larger than recent conventional estimates, however. For instance, Dougherty and Jorgenson reported a 16.5 percent gap for 1989, and Hall and Jones a 29.5 percent difference in 1988.[18] There are several reasons for these discrepancies. The most important reason is the inclusion of the nonmarket sector in the earlier productivity estimates. Reported value added of the Japanese nonmarket sector, relative to labor and capital inputs, is much higher than it is in the United States. Because of the problems in comparing nonmarket sector output across countries, I believe that the apparent high productivity in the government, health, and education sectors is not meaningful and that the market economy estimate is a more meaningful measure of aggregate industrial productivity. Another reason is the large Japanese investment volume before 1992 that is only partially captured in the earlier estimates and accounts for about a 5 percentage point decrease in relative TFP over the 1991–1995 period. The difference between a stock and a service-based estimate is of minor importance.

The bottom rows of table 3 separate TFP into labor and capital productivity. The market level results are graphically displayed in figure 3. Germany has a labor productivity slightly below that of the United States and a substantially lower capital productivity. Labor productivity is much lower in Japan than in the United States and Germany. Capital productivity in Japan is only slightly lower than in Germany and much lower than in the United States. Approximating the production technologies by a Cobb-Douglas function with a labor share of 0.36 produces the data in figure 3a. Germany and the United States have higher capital intensities and higher labor productivities than does Japan. These higher labor productivities might be expected from high capital investment. The comparison between Germany and the United States yields a counterexample, however: the higher German capital intensity does not yield a labor productivity higher than in the U.S. market sector.

18. Dougherty and Jorgenson (1996); Hall and Jones (1996).

Figure 3. Capital Productivity, Labor Productivity, Capital Intensity, and TFP



Source: Author's construction.

Figure 3b shows that diminishing returns are not the only reason for low German capital productivity. The German market sector could theoretically have reached the best-practice point for its high level of capital intensity (marked by a square). At this point, capital productivity would be about 80 percent of the U.S. level. In this sense, about two-thirds of the capital productivity gap is due to diminishing returns, one-third wasted in lower TFP. The inefficient use of resources, labor, and capital is likely to have increased capital intensity if labor was relatively more expensive, however. The higher German labor costs relative to capital, as discussed later, would rationalize a capital intensity of only 126 percent of the U.S. level. At this point, marked by an asterisk, capital productivity would be at 86 percent.

Capacity Utilization

I turn now to the microeconomic evidence to understand what caused the other half of the capital productivity gap, in particular, whether part of the high capital intensity was "wasted" in inefficient capital management. Capacity utilization in the food processing and automotive industry is defined as the running time of machines. Because of maintenance, repairs and refitting, a limited number of shifts, and holiday closings, machines are not run twenty-four hours a day every day. In the retail industry, capacity may not be fully utilized because shops are closed at times when customers would like to patronize them. In the electric utilities industry, capacity utilization is the combination of grid capacity utilization (kWh per kilometer of power lines) and power generation capacity utilization (the ratio of actual generation to installed capacity). Finally, in telecommunications, capacity utilization is defined as the number of call minutes per access line.[19]

Table 4 summarizes the estimates of capacity utilization and displays capacity creation, which is defined and discussed later. Because of a lack of comparability in publicly available data, McKinsey benchmarking comparisons were used at the company and plant level and normalized by setting utilization in the United States equal to 100. Capacity utilization was lower in Germany and Japan than in the United States in almost all industries. There were, however, marked differences

19. In 1994, there were no technical capacity constraints for call minutes. Excess network capacity was actually about 60 percent in the United States.

Table 4. Capacity Utilization and Capacity Created
Percentage relative to U.S. = 100

Country	*Automotive*	*Food processing*	*Retailing*	*Telecommunications*	*Electric utilities*
Capacity utilization					
Germany	75	75	96	46	90
Japan	115	62	100	44	51
Capacity created					
Germany	87	93	115	82	89
Japan	85	92	65	104	86

Source: McKinsey Global Institute (1996). See table 3 for relevant time periods.

across industries and between Germany and Japan. The difference is most striking in telecommunications and electric utilities. Capital management is potentially important in these industries because capital's share is so large (64 percent of value added in the telecommunications industry and 72 percent in electric utilities).

Japan is the benchmark in terms of TFP and also has the highest capacity utilization in the *automotive industry*.[20] Germany lags behind Japan and the United States. One component of capital utilization is plant operating hours. In 1991–93 plants in Germany operated between 3,500 and 4,000 hours a year; in the United States, 3,800–5,000 hours; and in Japan, 3,800–5,600 hours. Differences in the number of shifts account for only a small portion of these operating hour differences. Japanese and German plants uniformly ran two shifts a day, as did most U.S. plants; the exception was U.S. stamping plants, where three shifts were common. The main difference comes from fewer days worked per year in the United States and Germany, and a slightly shorter average shift length in Germany. These differences can be attributed to different labor-leisure trade-offs. There were also considerable differences in machine downtime during operating hours. These differences are important for assessing the role of capital management. Japanese plants reached an ''uptime'' of almost 95 percent during 1991–93, but uptime was less than 90 percent in the United States and only about 75 percent in Germany, largely because of frequent changeovers in both countries and a significantly higher rate of stopping to rework defects in German

20. The industry includes parts and assembly of cars and trucks. Parts and assembly could not be separated for Germany. U.S. plants include Japanese transplants; German plants include Ford and GM (Opel).

plants. The differences in plant operating hours and uptime imply that Japan's capacity utilization is 15 percent higher than in the United States and 40 percent higher than in Germany; in both comparisons, the overall differences were about equally divided between differences in plant operating hours and differences in machine uptimes.

These figures aggregate over important differences across segments and individual companies. Japanese auto assembly is actually less capital productive than U.S. assembly. That is offset, however, by a 20 percent capital productivity advantage in the parts segment of the Japanese automotive industry. The variation across companies is also large. Lieberman, Lau, and Williams report that in 1987 General Motors was less productive than the German auto industry, whereas Ford and Chrysler had already made major productivity improvements and had nearly attained Japanese productivity levels.[21] Similar intraindustry variation held for Japan. In 1987 Toyota had a 15 percent capital productivity advantage over Nissan, a 25 percent advantage over Mazda.

Plant operating hours and machine uptime are also the main factors determining capacity utilization in the *food processing* industry, which features large differences across plants and subindustries.[22] The comparison between the automotive and the food processing industry also shows that country patterns are by no means uniform. Whereas the Japanese automotive industry had both longer operating hours and less downtime than their U.S. and German counterparts, this pattern was reversed in the food processing industry. Thus, differences in operating hours and downtime cannot simply be attributed to countrywide labor and capital market factors. In the dairy industry, an example from the lower end of the productivity distribution across food processing subindustries, the average U.S. plant ran 18.6 hours a day, compared with 13.8 and 11.8 hours in Germany and Japan, respectively. Of that, total daily downtime was 1.5 hours in the United States, 2.2 hours in Germany, and about 5 hours in Japan. The low machine uptime in Japan was due mainly to frequent changeovers, while the difference between the United States and Germany was caused mainly by unbalanced pro-

21. Lieberman, Lau, and Williams (1990).

22. The food industry includes all foodstuff that does not go directly from the farm to the grocer. Excluded are beverages. Pet food is not included in the U.S.-Japan comparison. Differences across plants and subindustries are discussed in more detail in McKinsey Global Institute (1996).

duction lines, where congestion led to stoppages. Taking plant operating hours and machine uptime together, capacity utilization was 25 percent lower in Germany and 38 percent lower in Japan than in the United States.

In the *retailing* industry, capital utilization was the same in Japan and the United States. Restrictions on store opening hours reduced capital utilization in Germany.[23] Estimates of this effect are controversial because little is known about how much shopping during extended hours is simply substituted from other times. According to one estimate, value added in the German retailing industry would increase by about 4 percent if store hours were completely liberalized. This estimate is very conservative because it does not consider second-round effects such as a shift from low to high productivity formats in response to different shopping habits.[24]

In the telecommunications and electric utility industries, capacity utilization is more about spreading the costs of a large fixed asset base than about operating hours and machine uptime. In *telecommunications*, local calls made the main difference.[25] The United States had 2,801 local and 418 long-distance call minutes per access line in 1994, compared with Germany, which had 930 local and 401 long-distance call minutes.[26] Capacity constraints do not account for the difference—call volume in 1994 did not come close to the technical capacity in either country. German capacity utilization in the local loop was 33 percent of the U.S. level, and in total calls 46 percent.[27] In Japan, call volume was 44 percent of the U.S. level. A significant part of the lower call volume can be explained by price differentials, in particular free local calls in the United States. The telecommunications industry is an example where labor and capital productivity can be simultaneously

23. Retailing in this study is restricted to general merchandise, excluding food, car, gas, drugs, and liquor.

24. Ifo-Institut (1995). "Formats" in retailing refer to the distinction among department stores, discount stores, specialty stores, and small "mom-and-pop" retailers with fewer than five employees.

25. The telecommunications industry is defined here as public wireline and cellular operations. Not included are private networks, equipment, cable services, and bulk line leasing.

26. FCC Statistics of Communications Common Carriers, 1995; Siemens International Telecom Statistics, 1995.

27. This figure adjusts for the different service areas (local vs. long-distance) between Germany and the United States.

improved because funneling more calls through already installed access lines requires no new capital and relatively little additional labor. Because of capital's large share, however, spreading the fixed asset base is particularly important in increasing TFP.

Patterns in the *electric utilities* industry resemble the telecommunications industry.[28] Varying widely across the three countries, utilization of generation capacity is highest in Germany (50.5 percent of installed capacity), lowest in Japan (38.6 percent). The United States is in the middle (46.5 percent). This variation is attributable mainly to demand-side management, in particular peak-load pricing schemes in Germany and the United States. Utilization of the grid capacity differed even more: Germany's grid utilization was 63 percent of the U.S. utilization rate, more than offsetting the German advantage in higher generation capacity utilization. Japan had a particularly low grid capacity utilization of 36 percent of the U.S. level. Geography explains only part of these differences; the main explanation is differences in consumption. The grids are designed for similar throughputs in all three countries, but per capita electricity consumption is twice as high in the United States as it is in either Germany or Japan.

Capacity Creation

The second component of capital productivity is called capacity creation. Once capacity utilization has been measured at the plant level, capacity creation is simply capital productivity divided by the capacity utilization rate.[29] The figures for capacity created, shown in table 4, reflect output per unit of capital relative to that in the United States (which is again set equal to 100), after adjusting for differences in utilization rates. In some industries, capacity creation has a simple interpretation. In retailing, it is decomposed into two components: the value added per volume unit of goods sold, and the throughput in terms of volume units of goods sold per capital services used.[30] In telecom-

28. The industry comprises generation, transmission, and distribution. Independent power producers and autogenerators were excluded because capital expenditure data was unavailable. For detailed data sources, see McKinsey Global Institute (1996).

29. At the industry level, this relation is confounded by mix effects. See later discussion.

30. Throughput is a physical measure: sales divided by the consumer goods PPP. As opposed to most other studies of retailing, the output measure used here is value

munications, capacity created is the number of access lines; in the electric utilities industry, the amount of capacity (in megawatts) per unit of capital invested.

As a residual, the measure includes a whole range of components, of which I try to isolate the most important ones in assessing the effectiveness of capital management whenever possible. One such component is overinvestment in or "overengineering" of asset features or functions that do not contribute to an increase of output quantity or product quality for which customers pay. Another important component, related to both labor and capital management, is the defect rate. Defects reduce the ratio of output to capacity at a given utilization rate. Capacity creation is also affected by the choice of technology and by product mix. The McKinsey team isolated heterogeneity of technology by looking separately at well-defined subindustries (such as nuclear, fossil fuel, and hydropower plants) and then analyzing mix effects and product heterogeneity by applying product-specific PPPs.

There are obvious limits to the concept of capital creation as an instrument to gauge the efficiency of capital management. For instance, overengineering is clearly a capital management and purchasing decision constrained by safety and environmental regulations, whereas defect rates are functions of both labor and capital management. Moreover, capacity utilization and capacity creation are not necessarily independent from each other. For example, a higher utilization rate may come at the expense of maintenance and may therefore produce a higher defect rate.

In the *automotive industry*, the main story is "lean production": using simple machines lowers the capital requirements per line and reduces the defect rate at the same time, thus increasing net output per line.[31] For example, Japanese car makers stamp 50 percent more cars per press line than American producers, and the Japanese defect rate is 32 percent lower than in American plants and 56 percent lower than in European plants.[32] Ironically and much less known, the steep increase in automation and other capital between 1987 and 1993 in Japan sig-

added, which does not include intermediate service, rather than gross margin, which does.

31. The term "lean production" was coined by the MIT International Motor Vehicle Program. See Lieberman, Lau, and Williams (1990).

32. Harbour (1994).

nificantly raised the capital used per unit of production capacity, fully offsetting the Japanese advantage in higher capacity utilization. In 1987 capital intensity in the three countries was roughly comparable (91 percent of the U.S. rate in both Germany and Japan). From 1987 to 1992, capital intensity in Japan rose to 136 of the U.S. level (in Germany to 116 percent), while U.S. capital intensity remained unchanged. This increase in capital intensity drove Japanese TFP growth in the automotive industry well below U.S. TFP growth.[33]

In the German auto industry, the benchmarking studies found many instances of overengineered processes, such as higher levels of precision than tasks required. For instance, one German auto manufacturer made cylinder borings with almost double the precision of the industry standard. According to managers of this company, the additional precision neither smoothed engine movement nor prolonged engine life. After a financial crisis, the company began to make its borings with standard precision, evidently without loss of consumer satisfaction. In general, German plants typically needed more than five stamping steps to mold body panels, one of the most capital-expensive steps in car manufacturing, whereas Japanese plants require at most four. Again, major German automakers are improving their stamping process as part of the current process of restructuring.

The *food industry* was historically regionalized in all three countries, largely because of inability to transport perishable products over longer distances. After cooling technology lifted this constraint, the United States was faster to rationalize capacity by shutting down marginal plants. Japan and Germany still have excess capacity. The dairy industry is a case in point: The number of milk manufacturers in the United States fell from 4.1 per 1 million inhabitants in 1977 to 2.0 in 1992, while machine operating time increased to 18.6 hours a day, corresponding to 66 percent capacity utilization. Total factor productivity of the U.S. dairy industry increased 43 percent. In Germany, consolidation reduced the number of milk industry manufacturers from 5.4 to 3.2 per 1 million inhabitants, which was not enough to eliminate excess capacity. Machine run time was actually reduced to 11.8 hours a day,

33. For example, the decision by Honda to build a new air-conditioned assembly plant was driven by an expected boost in car sales, a need to provide amenities to an expected scarcity of laborers, and a perception of very low costs of capital. This plant severely reduced Honda's capital productivity.

corresponding to a capacity utilization of only 42 percent. TFP increased only 31 percent in Germany. Throughout the food processing industry, marginal plants in Japan spent more assets in logistics and distribution per unit of products than did larger plants in Japan, and marginal plants in Germany wasted assets in imbalanced production lines and other operational practices. Although a low utilization rate was pervasive in both countries, these wasteful practices reduced capital productivity by another 7–8 percent.

German *retailers* maximized the capacity created with a given set of assets. The main factor in retailing is floor space, and German retailers use much less floor space than do U.S. firms to generate comparable sales. German department stores, for instance, generated sales of $3,400 a square meter in 1992, U.S. department stores only $1,900. The difference is more pronounced in specialty and discount stores, less so in the small mom-and-pop stores. On average, throughput per unit of assets was 20 percent higher in the German retail industry, giving it a distinct advantage relative to the U.S. industry. At the same time, U.S. retailers achieved high capital productivity by offering more service than did retailers in Germany.[34] The U.S. value added per unit of throughput is about 10 percent higher than in Germany. Japanese retailers have about 25 percent less throughput per invested capital and about 15 percent less value added per throughput than do U.S. retailers.

In the *telecommunications* industry, Japan and the United States had roughly the same levels of capacity creation. Japan used slightly less capital per access line than did the United States. The German Telekom monopoly, however, spent 18 percent more capital per access line than Japan and the United States.[35] About half of that was spent on more costly underground wires. This difference has two components: Germany might have saved approximately 50 percent of the difference if it had adopted the U.S. aerial to underground cable mix at U.S. cable prices. Because underground cables are likely to provide more aesthetic appeal and are more reliable in preventing power outages, this component reflects a weakness in the output measure rather than a lack of

34. This effect is probably underestimated.

35. In 1994 German Telekom had a 90 percent market share in the entire industry, and a 100 percent share in wireline. In the United States, AT&T had a 24 percent share, other former Bell companies an additional 44 percent. In Japan, NTT had a 70 percent market share.

productivity. The other 50 percent, however, represents overengineering in the sense that these underground wires are unnecessarily costly: they are required to be able to withstand the full impact of being run over by a tank without losing their ability to function even though they are buried almost one meter deep. The German telecommunications industry also failed to reconfigure existing assets to free up hidden capacity as was done in the U.S. industry. Instead German Telekom provided a huge ISDN (Integrated Services Digital Network) capacity that was not used much during the 1992–94 sample period. Admittedly, the static productivity measure used here penalizes such future-oriented investments, but it is not clear whether these investments were sound. Most industry experts interviewed for this study voiced doubts and would have recommended a more phased implementation that reduced the danger of obsolescence. The developments in the wake of the German telecommunications privatization after January 1998—the usage of existing but unused parallel grids and the development of asynchronous data transmittal techniques leapfrogging ISDN—are evidence in favor of this opinion.

In the *electric utility* industry, the United States produced about 10 percent more kilowatt hours per invested assets than did Germany and Japan. According to German industry specialists, the German electric utilities tended to spend much more to produce the same amount of electricity. Examples are thicker concrete walls housing generators and unnecessarily spacious walks to rarely used devices. In Japan, several power plants were not connected to the grid by 1993. These plants were built because of a projected steep rise in demand, which did not actually materialize until 1998. This unused capacity accounts for a quarter of the capital productivity difference between Japan and the United States.

Slack in capacity utilization thus accounts for most of the capital productivity gap among Germany, Japan, and the United States.

Mix Effects

In a given industry made up of different subindustry segments, mix effects could contribute to differences in capital productivity at the industry level. In no case in practice did the mix of subindustries affect the capital productivity ranking for the overall industry. The McKinsey team, however, found significant mix effects in the food and electric utility industries. Japan's seafood industry holds a disproportionately large part of the overall food processing industry, and its capital productivity is substantially above average (81 percent versus 64 percent of U.S. level).[36] Relative productivity rankings were similar across the other food categories such as bakery, meat, and dairy. Taking these mix effects into account raised Japanese capital productivity in the food industry by 11 percent relative to a U.S.-type industry structure. Utilization, capacity creation, and relative shares of total energy production in the electric utility case differed significantly by fuel type. Germany, for instance, had more nuclear power plants than the United States and Japan, and German nuclear plants were far more capital productive than U.S. nuclear power plants.[37] The reverse was true for fossil-fuel plants. These differences approximately offset each other, however, so the mix of subindustries did not contribute much to capital productivity differences at the industry level.

Capital Management

What explains these differences in capital utilization and creation? This section explores five dimensions of capital management: operations effectiveness, product-line management, pricing, capital purchasing decisions, and industry chain management. Other dimensions, such as differences in technology, are omitted because they appear to be much less important in explaining capital productivity differences. There is one important exception discussed later—the heavy automation of the Japanese auto industry around 1990.

Operations Effectiveness

The way in which firms organize and operate their plants, stores, and networks is a critical factor in explaining differences in capital

36. The value added share of seafood is 15 percent in Japan, compared with 3 percent in both Germany and the United States.

37. Nuclear power plants supplied 27 percent of total electricity generation in Germany in 1993, 15 percent in the United States, and 20 percent in Japan. Relative to the average capital productivity of all U.S. power generators, U.S. nuclear power plants had a productivity of 46 percent, while fossil-fuel plants were at 166 percent. In Germany, productivity of nuclear power plants was 80 percent of the average U.S. level, productivity of fossil-fuel plants was 94 percent of the average U.S. level.

productivity across countries. In general, operations effectiveness improves both capital and labor productivity. Baily and Gersbach provide many examples, which do not need to be repeated here, about how a better organization of workers' functions and tasks improves output per worker.[38]

Operational effectiveness also has specific implications for capital productivity. First, better practices improve utilization by reducing machine downtime. This is most important in manufacturing industries in which downtime is a substantial determinant of capital utilization. On average, Japanese auto manufacturers set up faster during changeovers and stop machines for less time to fix process problems.[39] Second, good machine design increases the effective capacity of a line per unit of invested assets. Again, the auto industry illustrates the point. Japanese manufacturers used better design for manufacturability, as well as their continuous improvement *(kaizen)* approach, to reduce the number of production steps and lower the defect rate. In addition, one may argue that consumers recognize and pay for the higher reliability that is frequently associated with a lower defect rate in the factory. All three mechanisms are examples of capital-related management actions that raise the numerator in both capital and labor productivity.

Product-Line Management

Most types of machines can be adapted to multiple tasks. Adaptation has the advantage of spreading capital costs, but it also involves costly downtime. Product-line management refers to the trade-off between task variety and capital utilization. Effective product-line management boosts capital utilization by optimizing this trade-off.

An example is the Japanese food industry, which had three times as many different food products (measured in stockkeeping units) per unit of sales volume in 1992 than the United States. Such variety may be a good thing in principle, but the Japanese trade-off appears to be inefficient because the added variety in Japan does not result in a higher value-added food industry. At the same time, Japan's average utilization rates are less than two-thirds of the U.S. level. A particularly

38. Baily and Gersbach (1995).

39. This point is well known and has been documented; see, for example, Lieberman, Lau, and Williams (1990).

Table 5. Mix and Productivity of Retailing Formats, Japan and the United States

Category	*Mom-and-pop stores*	*Department stores*	*Discount stores*	*Specialty stores*
Mix of formats (percent of capacity)				
United States	9.8	12.1	22.6	55.5
Japan	24.9	29.9	0.4	44.8
Japanese productivity (relative to U.S. = 100)				
Capital productivity	10	80	105	120
Labor productivity	15	95	90	120
TFP	15	90	94	120

Source: McKinsey Global Institute (1996, "retail," exhibits 10, 12).

dramatic example is the Japanese dairy industry, where lines must stop for every change in container size or milk-fat content. As a result, total dairy shutdown time is about three times longer than in the United States and Germany, and changeovers occupy more than 30 percent of total operating time (compared with 9 percent in the United States and 14 percent in Germany). The benchmarking studies showed many world-class manufacturers, including some in Japan, who used market research to help them avoid excess product variety and improve the trade-off between product variety and plant utilization.

In retail, the evolution of different selling formats represents an important improvement in product-line management. The difference between Japan and the United States is particularly impressive. Specialty stores have a distinct productivity advantage in Japan, while small mom-and-pop stores fare particularly badly (table 5). This is most pronounced in terms of capital productivity. The different format mix accounts for more than 50 percent of the capital productivity difference between Japan and the United States.

Pricing

Pricing is the most important factor in explaining differences in capacity utilization in telecommunications and electric utilities. In the U.S. telecommunications industry, flat rate pricing and low price levels relative to other goods and services stimulated higher levels of demand over the largely fixed asset base, resulting in higher utilization than in Germany or Japan. To show how much pricing affects capacity utilization, the McKinsey team converted the German and Japanese pricing system to the U.S. system and applied a conservative price elasticity estimate of −0.3 for local and −0.7 for long-distance calls.[40] The difference is particularly dramatic for Germany, where a call minute is on average 60 percent more expensive than in the United States; the price differential in Japan is 20 percent. Germany would increase its call minutes per access line from 46 percent to 82 percent of the U.S. level, and Japan from 44 to 56 percent, if these countries were to switch to the U.S. pricing system with free local and cheaper long-distance calls.

In the electric utilities, capacity utilization heavily depends on the daily and annual variability of the load curve. Innovative pricing structures, such as time-of-use pricing, have proved effective in both Germany and the United States by reducing demand at peak time periods. Japan did not charge different time-of-use prices in the period under consideration. As a result, demand was much more volatile there, and average capacity utilization was low. Demand at the annual peak hour was 28.3 percent higher than average demand in Germany (26.5 percent higher in the United States); in Japan the difference was 77.7 percent. Seasonal patterns do not explain the different utilization rates. Peak demand in Germany occurs during the heating season in February, whereas peak demand in Japan and the United States is during the air conditioning season in summer. Nor is scale an adequate explanation. The United States has a much higher total demand than Japan (11,170 kWh vs. 5,029 kWh per capita in 1993). But Germany's scale (5,511 kWh per capita) is similar to Japan's, yet Germany has a much higher utilization rate.

Capital Purchasing Decisions

Several examples of unwise capital purchasing decisions were significant for the respective industries—at least in hindsight. Exaggerated demand forecasts led to too much capital investment in the Japanese electric utility industry. An overestimate of future labor shortages precipitated excessive capital-labor substitution in the Japanese automotive industry. The resulting overautomatization has been corrected in newer plants. The telecommunications industries of Germany and Japan have made huge investments in new technologies (such as ISDN and fiber-

40. Meyer (1980); Taylor (1979).

to-the-home) that are unlikely to pay back in the near and medium future. Managers in the German food processing industry did not eliminate underutilized capacity and consolidated much less than in the U.S. industry. Finally, there were many instances of overengineering in the German telecommunications and electric utilities industries.

Overengineering has two types of costs. The more obvious is the inefficiency of unused capacity. The second is that the excess capital is sometimes purchased at inflated prices. In the measure of physical capital productivity used here, most of the effects of pure price differences were removed through the application of investment goods PPPs. Although this process helps to isolate purely operational differences, it ignores the possibility that corporations in Germany and Japan could have paid less for their equipment, thereby improving financial performance. On average, capital equipment PPPs in Germany and Japan were 48 percent and 67 percent higher than the market exchange, respectively. These price differentials are striking because most equipment is tradable. In fact, interviews revealed frequent managerial biases toward locally produced equipment in both Germany and Japan. These biases were often not justified by barriers to global sourcing; rather, managers were either unaware of lower cost alternatives or were willing to pay more because of long-established relationships with local suppliers. Deutsche Telekom in Germany, for instance, paid local suppliers up to 60 percent above international prices. German auto manufacturers recognized the opportunity to reduce costs and moved to more global sourcing in the last several years. Only in some cases were local purchases at higher prices justified. In food processing in Japan, for example, some of the local price premium was offset by subsequent cost savings from local servicing and parts availability. In the automotive industry, stricter safety standards in Germany added about 10 percent to the average cost of machinery, even if imported, which, arguably, added to the utility of the German workers.

Industry Supply Chain Management

Industry supply chain management is the management of the upward linkages to providers of intermediate inputs and raw materials on the one side and the downward linkages to distributors and customers on the other side. Efficient management eliminates unnecessary interim steps, thereby saving capital in transshipping and storage facilities. The efficiency of chain management for one company is measured by comparing it to the way other companies have created higher or lower value added per capital and labor input with a different organization of the linkages with their suppliers and distributors.

Inefficient industry chain management reduced Japanese capital productivity relative to Germany and the United States. Most Japanese retailers and manufacturers employed a complicated multilayered distribution system, which in 1992 led to a three-fold higher ratio of wholesale to retail volume than in the United States, where both volumes were about equal.[41] In other words, for every hand a good went through in the United States, it went through three hands in Japan. The important point is that Japanese companies can do away with this multilayered distribution system. Most notably, the Japanese auto industry has improved capital productivity by making the management of its suppliers a critical part of its lean production system. This tactic has spread surprisingly little to the other Japanese industries in the McKinsey study, but several counterexamples in the Japanese food processing and retailing industries show it could be done. For example, Ezaki Glico demonstrated that high performance with low product variety is possible in the Japanese food processing industry. One large Japanese retailer—following the example of best-practice discount stores in the United States, which eliminated intermediaries and simultaneously reduced capital and labor costs—built up its own distribution system by reducing the capital devoted to distribution to less than half of what it had been.

Product and Capital Market Forces

Although this study has not provided a basis for a statistical test of the hypothesis, the findings are consistent with the view that pressure from product markets and capital markets increases capital productivity. Intense product market competition encourages managers to economize on the use of capital for any given level of output, in order to reduce costs and survive in the competitive environment. Pressure from

41. The ratio of wholesale to retail was about 1:1 in the United States and 3:1 in Japan.

capital markets to earn high returns also encourages effective capital management and is likely to be particularly important in utilities, where product market competition is limited. The way regulation affects product markets has a substantial impact on capital productivity.

The 1995 study by Baily and Gersbach reported a ''globalization index'' for auto manufacturing and food processing. They found that industries that had been exposed to competition with best practice had higher labor productivity. That correlation also holds up for capital productivity. The U.S. auto industry has faced more exposure to the best-practice Japanese industry than has the German industry, and U.S. capital productivity is higher. The German food processing industry has faced much more competition from best-practice international companies than has the Japanese industry, and German capital productivity is higher.

Of course, this finding on capital productivity is not independent of the prior results for labor productivity. Competitive pressure that encourages higher total factor productivity can increase both labor and capital productivity. But this study has drawn attention to capital management decisions that can reduce the need for capital with a given level of output and labor input. In theory, even a monopolist will minimize costs, but this study finds that in practice competitive pressure forces efficiency in capital use in a way that does not occur without such pressure.

Regulation of retailing in Japan, for example, is setting the parameters under which competition can occur. Restrictions on land use and complex and restrictive regulations that make it difficult to open large stores have limited the evolution of the industry. Highly productive formats, such as discounters, category killers, and specialty stores are restricted in order to protect the mom-and-pop incumbents. This regulation reduces capital as well as labor productivity. Product market competition is lessened because productive new entry occurs only very slowly.

Regulation is clearly important also to the electric utility and telecommunications industries. Its main impact appears to be in setting management objectives, a topic I turn to now as I look at the impact of capital markets.

Because there is no quantitative measure of the strength of capital market forces, the McKinsey team looked at several dimensions: access to capital; corporate governance mechanisms, in particular management objectives; and ownership structure. Managerial objectives and their alignment with productivity showed a high degree of variability. In most companies of the German and U.S. nonmonopoly industries, profit maximization and financial performance were the main objectives. This was different in Japan. In the auto industry, productivity itself was a main goal; in the food processing and retail industry, it was sales maximization.[42] Management objectives in the telecommunications and electric utility monopolies were mainly determined by the type of regulation. U.S. telecommunications managers faced rate-of-return (ROR) and price regulation and Japanese managers operated under a pure ROR regulation. German telecommunications managers were given a host of competing objectives—universal service for consumers, high quality and technological excellence, and profits to subsidize the postal system, which was also state-owned before the recent divestiture—that created clear objective function for managers and provided little direct pressure on them to use resources productively. In the electric utilities, ROR regulation was widespread, although the United States was first to introduce prudence reviews and price caps.

Ownership explains many of these differences. The clearest example is state ownership. In telecommunications, U.S. firms are private, common stock companies, while Deutsche Telekom and NTT (Nippon Telephone and Telegraph) are state-owned. In turn, most electric utilities in Japan and the United States are private, common stock companies, while most German utilities are either state-owned outright or have a state majority on the board. The situation in the nonmonopoly industries is more complex. German company ownership is typically interlocked in a complicated way among banks, insurance companies, and other production companies, diffusing the line of control.[43] A similar structure holds in the Japanese retail industry, where conglomerates cross-subsidize underperformers. In food processing, the German small and medium companies are mainly regional agricultural cooperatives that oppose interregional consolidation, while Japanese firms are privately held. In all of these cases, the market for corporate control is ineffective.[44]

42. This has been extensively documented; see, for example, see Kagono and others. (1985).

43. Cable (1985), Kaplan (1995), and Wenger and Kaserer (1997) provide a British, an American, and a German view, respectively.

44. See Jensen (1983, 1988) for concept and Franks and Mayer (1990) for a comparison of France, Germany, and the United Kingdom.

Capital Productivity and Financial Return

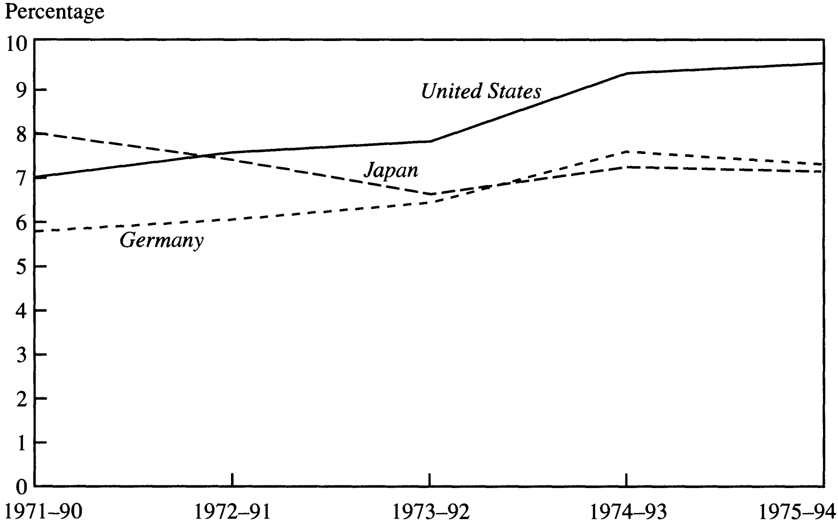
A focus on financial performance, especially prevalent among U.S. firms, did create a clear performance objective that turns out to be generally aligned with capital productivity. The argument can be formalized: under a Cobb-Douglas technology, the rate of return to capital is proportional to average capital productivity ($r = (\partial Y/\partial K = \alpha\ Y/K)$. So (physical) capital productivity is likely to be correlated with the (financial) rate of return as long as the factor of proportionality, the output elasticity of capital services, remains roughly constant. On the aggregate level, the constancy can be tested because it corresponds to capital's share of income under constant returns to scale and competition.

Empirically, physical capital productivity was indeed mirrored in financial capital performance on the aggregate level. From 1974 to 1993, financial performance in the United States was significantly better than it was in Germany and, on average, better than in Japan. Financial performance was calculated by relating the payouts from the corporate sector (interest, dividends, and capital gains) to flows into the corporate sector (debt and equity) through the corresponding internal rate of return, including the initial and final stock of financial wealth.[45] Results are displayed in figure 4.

For the twenty years between 1974 and 1993, the annualized aggregate rate of return was 9.1 percent in the United States, compared with 7.4 percent in Germany (figure 4) and 7.1 percent in Japan. These estimates are robust to changes in definition and computation period for the U.S.-German comparison. The high income share to capital in the early 1970s and the Japanese bubble at the end of the 1980s make the U.S.-Japan comparison subject to higher variance. In my view, the comparisons are meaningful only when they cover the full cycle of bubble boom and burst, that is, when they include at least some years from 1992 onward and exclude the very early 1970s, when Japan's capital market development was not comparable to the markets in the United States and Europe.

45. The computation is based on the flow of funds data in the OECD National Accounts, augmented by capital gains from Standard and Poor's 500 (U.S.); DZ-Index of all publicly listed companies (Germany); and Index of all Section 1 companies listed on the Tokyo Exchange (Japan). For details, see McKinsey Global Institute (1996).

Figure 4. Aggregate Rate of Return during Different 20-Year Windows



Source: McKinsey Global Institute (1996, "financial performance," exhibit A11).

This empirical relation also holds on a more disaggregated level, that is, within one sector in one country. Table 6 shows as example the U.S. retailing sector. Capital productivity and financial returns are highly correlated as more productive formats earned higher returns and created more appreciation during the 1985–94 period.

There are several reasons why the correlation between productivity and financial performance is not perfect. It is broken in product markets with low competitive intensity. For example, a monopoly such as

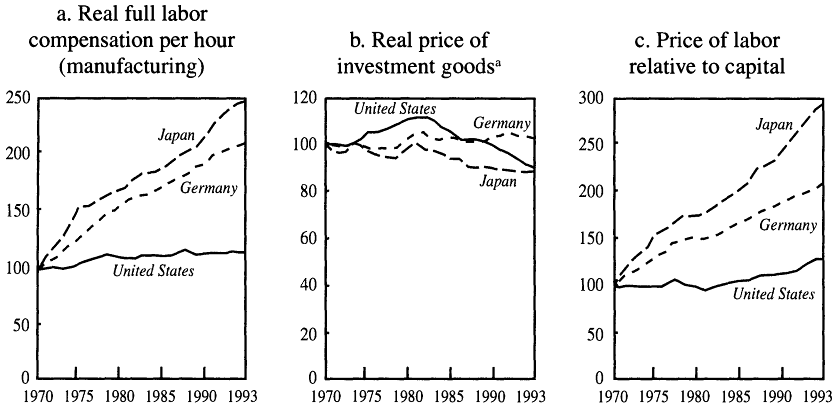
Table 6. U.S. Retail Capital Productivity and Financial Performance
Percent

Retail format	*Capital productivity (1992) (retail average = 100)*	*ROIC (1985–94 average)*	*Change in market value (1985–93)*[a]
Department	80	9.8	24
Discount	105	11.2	86
Specialty	120	15.4	82

Source: McKinsey Global Institute (1996, "synthesis," exhibit 14).
a. Defined as change in market value minus invested capital, divided by average invested capital.

Figure 5. Relative Costs of Labor and Capital, 1970–1993

1970 = 100



Sources: Bureau of Labor Statistics, Institut der Deutschen Wirtschaft, OECD.
a. Price index of gross fixed capital formation divided by gross domestic product deflator.

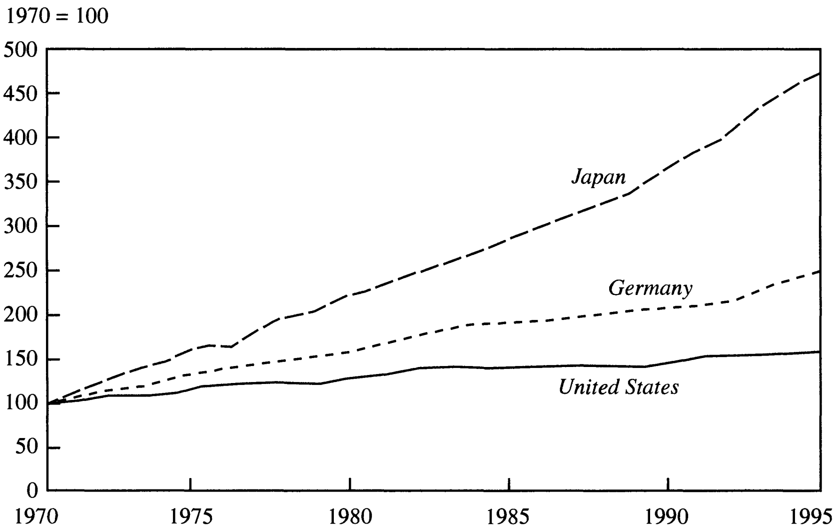
Deutsche Telekom has low productivity but high profitability through its ability to sustain high prices. Trade protection in the German and U.S. auto industry allowed the industry to earn profits despite low productivity and corporate governance that failed to apply pressure effectively until firms were close to running out of cash (General Motors in the United States, Daimler Benz in Germany). The capital market itself also introduced distortions, as evidenced by the impact of the bubble economy in Japan, which distracted retailers' attention away from operational performance in their core business to real estate speculation.

Macroeconomic Environment

The macroeconomic environment—most notably the relative price of labor and capital—plays a central role in determining capital intensity. In the simplistic Cobb-Douglas world, capital intensity is proportional to the relative price of labor to capital.[46] Figure 5 shows that the real price of capital did not change much in any of the three countries

46. The factor of proportionality is capital's share divided by labor's share.

Figure 6. Capital Intensity, Market Economy, 1970–1995



Source: Author's calculations based on data from Bureau of Labor Statistics, Institut der Deutschen Wirtschaft, and OECD.

from 1970 through 1993.[47] Real hourly labor compensation more than doubled in Germany and Japan, however, while it increased only moderately in the United States. The price of labor relative to capital increased by about 25 percent in the United States, by more than 100 percent in Germany, and by almost 200 percent in Japan (figure 5). The relative increases of the capital intensities in the three countries reflect these price changes (figure 6). Capital intensity in the market sector rose by slightly more than 50 percent in the United States, by 130 percent in Germany, and by 330 percent in Japan.

Figures 5 and 6 refer to intertemporal changes. The cross-national variation in the relative price levels of labor to capital shows a similar qualitative relation. In 1995 labor compensation per hour (measured in gross domestic product PPP) was 19 percent lower in Japan and 21 percent higher in Germany than in the United States.[48] This implies that

47. The inclusion of cross-national interest rate variation does not change this overall picture.

48. Labor compensation: Institut der Deutschen Wirtschaft, 1995, table 149. PPPs and price of capital: table 1 of this paper.

the relative price of labor to capital in Japan was 86 percent of the U.S. level, and 126 percent in Germany. These levels correspond qualitatively to the capital intensities: Japan 85 percent, and Germany 141 percent, when U.S. capital intensity is normalized to 100 percent.

The TFP differences displayed in figure 3 and table 3 show that relative factor prices do not fully explain capital intensities. Some labor and capital is used less efficiently in Germany and Japan. Because labor and capital management is interwoven in so many respects, there is no clean accounting possible of how much capital and how much labor is wasted.

Other labor market factors were not generally important in explaining capital productivity differences. For example, no evidence was found to suggest that differences in labor skills were important in explaining productivity differentials. Labor rules and unionism had only secondary influence in the food and auto cases in raising the premium required for third-shift work, primarily in Germany. The demographics of labor supply in Japan created a perception of an impending labor shortage and fueled automakers' decisions to invest heavily in automation. In no other industry, however, did demographics emerge as a factor that caused international differences in capital productivity.

The Japanese bubble economy during the second half of the 1980s had some influence on capital productivity. First, the high cost of land created by the bubble created artificial barriers to entry in the retail industry. In addition, retailers focused on speculative land acquisition in Japan, which distracted their attention from retail operations. Third, the bubble affected the level of capital spending by distorting the perceived cost and the availability of capital. This was particularly significant in the Japanese auto industry and was another factor in the excessive automation that decreased capital productivity. This contrasts sharply to the early days of the industry, in which scarce capital forced manufacturers to use existing assets extremely productively, creating lean production.

Conclusions

The five industry case studies and the aggregate analysis show that capital productivity in Germany and Japan was significantly below capital productivity in the United States for the sample period. Between 1991 and 1995 market sector capital productivity in Germany and Japan was only about two-thirds of the U.S level. Only in the Japanese auto industry and in German retail was capital productivity at par with the United States. No accounting mechanism can cleanly measure how much of this gap in capital productivity was caused by wasted capital and how much by worse labor management. But if Germany had achieved the U.S. level of TFP, its actual capital intensity should have given it capital productivity of 80 percent of the U.S. capital productivity. The main finding of this study is that part of the high capital intensity appears to have been wasted. The high price of labor in Germany relative to capital rationalizes only a lower capital intensity, at which capital productivity should have reached 86 percent of the U.S. level, rather than the 68 percent it actually attained. The Japanese market sector had a lower capital intensity, so diminishing returns are not an explanation of the low Japanese capital productivity, reflected in the even lower Japanese TFP. The case studies revealed how investment, capital management, and pricing decisions can affect capital utilization and capital productivity. Some findings, such as the importance of peak-load pricing in electric power are well known, although the magnitude of the impact across countries was revealing. Other results, such as the importance of downtime in food processing and automaking or the overengineering in telecommunications and electric power, have not been emphasized in earlier work on productivity.

The causal analysis discussed here shows the importance of a functioning combination of product market competition and capital market pressures. Without product market competition, companies can conceal their lack of productivity by raising prices. Without capital market pressure, unproductive companies will not exit even in the face of product market competition. This linkage underlines the role of financial performance. That financial returns have been markedly and consistently higher in the United States than in Germany during the last two decades invalidates claims that the U.S. focus on financial performance—as opposed to the more holistic German view—is short-term and jeopardizes long-term economic performance.

References

Baily, Martin Neil. 1993. "Competition, Regulation, and Efficiency in Service Industries." *Brookings Papers on Economic Activity: Microeconomics* 2: 71–130.

Baily, Martin Neil, and Alan M. Garber. 1997. "Health Care Productivity." *Brookings Papers on Economic Activity: Microeconomics*: 143–202.

Baily, Martin Neil, and Hans Gersbach. 1995. "Efficiency in Manufacturing and the Need for Global Competition." *Brookings Papers on Economic Activity: Microeconomics*: 307–47.

Baily, Martin Neil, and Charles L. Schultze. 1990. "The Productivity of Capital in a Period of Slower Growth." *Brookings Papers on Economic Activity (special issue)*: 369–406

Blades, Derek W. 1991. "Capital Measurement in the OECD Countries: An Overview." In *Technology and Productivity: The Challenge for Economic Policy*. Paris: OECD.

———. 1993. "Comparing Capital Stocks." In *Explaining Economic Growth*, edited by A. E. Szirmai, Bart van Ark, and Dirk Pilat. Amsterdam: North Holland.

Börsch-Supan, Axel. 1998. *Retirement Income: Level, Risk, and Substitution among Income Components*. Aging Working Paper Series AWP 3.7r. Paris: OECD.

Cable, John R. 1985. "Capital Market Information and Industrial Performance: The Role of West German Banks." *Economic Journal* 95 (March): 118–32.

Conrad, Klaus, and Dale W. Jorgenson. 1995. "Sectoral Productivity Gaps between the United States, Japan, and Germany, 1960–79." In *Productivity, vol. 2 of International Comparisons of Economic Growth*, edited by Dale W. Jorgenson. MIT Press

Denison, Edward F. 1974. *Accounting for United States Economic Growth, 1929–1969*. Brookings.

———. 1985. *Trends in American Economic Growth, 1929–1982*. Brookings.

Dollar, David, and Edward N. Wolff. 1988. "Convergence of Industry Labor Productivity among Advanced Economies, 1963–1982." *Review of Economics and Statistics* 70 (November): 549–58.

———. 1994. "Capital Intensity and TFP Convergence by Industry in Manufacturing, 1963–1985." In *Convergence of Productivity: Cross-National Studies and Historical Evidence*, edited by William Baumol and Richard R. Nelson, pp. 197–224. Oxford University Press.

Dougherty, Chrys, and Dale W. Jorgenson. 1996. "International Comparisons of the Sources of Economic Growth." *American Economic Review* 86 (May): 25–9.

Franks, Julian, and Colin Mayer. 1990. "Takeovers: Capital Markets and

Corporate Control: A Study of France, Germany, and the UK." *Economic Policy: A European Forum* (April): 189–231.

Freudenberg, Michael, and Deniz Ünal-Kesenci. 1994. *French and German Productivity Levels in Manufacturing: A Comparison Based on the Industry-of-Origin Method.* No. 94–10. Centre d'Etudes Prospectives et d'Informations Internationales (CEPII). Paris.

Gersbach, Hans. 1997. "International Leadership in Productivity at the Aggregate and Industry Level." *Journal of Economic Surveys* 12 (1): 43–62.

Griliches, Zvi. 1992. *Output Measurement in the Service Sectors: Introduction.* University of Chicago Press.

Hall, Robert E., and Charles I. Jones. 1996. *The Productivity of Nations.* NBER Working Paper 5812. National Bureau of Economic Research, Cambridge, Mass. November.

———. Forthcoming. "Why Do Some Countries Produce So Much More Output per Worker than Others?" *Quarterly Journal of Economics.*

Harbour, Jerry L. 1994. *The Process Reengineering Workbook.* New York: Quality Resources.

Hooper, Peter. 1996. "Comparing Manufacturing Output Levels among the Major Industrial Countries." Paper presented at Expert Workshop on Productivity, OECD, Paris. May.

Ifo-Institut für Wirtschaftsforschung. 1995. *Das deutsche Ladenschlußgesetz auf dem Prüfstand.* Berlin: Duncker und Humblot.

Jensen, Michael C. 1988. "Takeovers: Their Causes and Consequences." *Journal of Economic Perspectives* 2: 21–48.

———. 1993. "The Modern Industrial Revolution, Exit, and the Failure of Internal Control Systems." *Journal of Finance* 48 (3): 831–80.

Jensen, Michael C., and Richard S. Ruback. 1983. "The Market for Corporate Control: The Scientific Evidence." *Journal of Financial Economics* 11: 5–50.

Jorgenson, Dale W., ed. 1995. *Productivity. Vol. 2 of International Comparisons of Economic Growth.* MIT Press

Jorgenson, Dale W., Frank M. Gollop, and Barbara M. Fraumeni. 1987. *Productivity and U.S. Economic Growth.* Harvard Economic Studies, vol. 159. Harvard University Press.

Jorgenson, Dale W., Masahiro Kuroda, and Mieko Nishimizu. 1987. "Japan-U.S. Industry-Level Productivity Comparisons, 1960–1979." *Journal of the Japanese and International Economies* 1 (March): 1–30.

Kaplan, Steven N. 1995. "Corporate Governance and Incentives in German Companies: Evidence from Top Executive Turnover and Firm Performance." *European Financial Management* 1 (March): 23–36.

Kagono, Tadao, and others. 1985. *Strategic vs. Evolutionary Management: A*

U.S.-Japan Comparison of Strategy and Organization. Advanced Series in Management. Vol. 10. Amsterdam: North Holland.

Kovenock, Dan, and Gordon M. Phillips. 1997. "Capital Structure and Product Market Behavior: An Examination of Plant Exit and Investment Decisions." *Review of Financial Studies* 10 (Fall): 767–803.

Lieberman, Marvin B., Lawrence J. Lau, and Mark D. Williams. 1990. *Firm-level Productivity and Management Influence: A Comparison of U.S. and Japanese Automobile Producers.* MIT Press.

Maddison, Angus. 1987. "Growth and Slowdown in Advanced Capitalist Economies: Techniques of Quantitative Assessment." *Journal of Economic Literature* 25 (June): 649–98.

———. 1993. "Standardized Estimates of Fixed Capital Stock: A Six-Country Comparison." *Innovazione e Materie Prime.* April.

McKinsey Global Institute. 1992. *Service Sector Productivity.* Washington, D.C.

———. 1993. *Manufacturing Productivity.* Washington, D.C.

———. 1996. *Capital Productivity.* Washington, D.C.

———. 1997. *Removing Barriers to Growth and Employment in France and Germany.* Washington, D.C.

———. 1998. *Productivity-led Growth for Korea.* Washington, D.C.

Meyer, John R., and others. 1980. *The Economics of Competition in the Telecommunications Industry.* Cambridge, Mass.: Oelgeschlager, Gunn, & Hain.

OECD (Organization for Economic Cooperation and Development). 1992. *Purchasing Power Parities and Real Expenditures, 1990—EKS Results.* Paris.

———. 1995. *Purchasing Power Parities and Real Expenditures, 1993—EKS Results.* Paris.

———. 1996. *National Accounts, Detailed Tables, 1981–1993.* Paris.

———. 1997. *National Accounts, Detailed Tables, 1983–1995.* Paris.

———. 1998a. *Maintaining Prosperity in an Aging Society.* Paris.

———. 1998b. *National Accounts, Detailed Tables, 1984–1996.* Paris.

O'Mahony, Mary. 1993. *"International Measures of Fixed Capital Stocks: A Five-Country Study."* National Institute of Economic and Social Research, London. September.

———. 1995. "International Differences in Manufacturing Unit Labor Costs." *National Institute Economic Review* (November): 85–100.

Pilat, Dirk. 1994. "International Productivity Comparisons—An Introduction." *Economie Internationale* 60: 11–32.

———. 1996. *"Labor Productivity Levels in OECD Countries: Estimates for the Manufacturing and Selected Service Sectors."* No. 169. OECD, Economics Department, Paris.

Taylor, Lester D. 1979. *Telecommunications Demand: A Survey and Critique.* Ballinger.

Van Ark, Bart, and Dirk Pilat. 1993. ''Productivity Levels in Germany, Japan, and the United States: Differences and Causes.'' *Brookings Papers on Economic Activity: Microeconomics 2:* 1–48.

Wenger, Ekkehard, and Christoph Kaserer. 1997. ''The German System of Corporate Governance: A Model Which Should Not Be Imitated.'' Economic Studies Working Paper 14. American Institute for Contemporary German Studies. Washington, D.C.

Comments

Comment by Paul Romer: One useful way to read this paper is as a coda to the cost-of-capital ''crisis'' that played out in the United States in the 1980s. Remember how the world looked then. Japan and Germany seemed unstoppable. Their firms had access to patient capital. Firms in the United States were hobbled by the short-term focus of equity markets. Even the firms that were trying to do the right thing and compete for the long run were forced to conform to the dictates of the market by insidious financial market innovations such as the leveraged buyout and the debt-financed hostile takeover. Serious commentators aruged that the Anglo-Saxon style of corporate financing and governance had no future and that the United States needed to remake its institutions along German and Japanese lines.

Now, everybody seems to know that this diagnosis was totally off the mark. But to a worrisome extent, this 180-degree reversal in public sentiment about capital market institutions seems to be based on the same kind of signal extraction mistake that caused the misdiagnosis in the first place. People treat each temporary cyclical development as a sign of a lasting change in underlying trends. When Paul Volcker cleaned up after the monetary mismanagement of his predecessors in the early 1980s, people misinterpreted the negative side effects—a recession, high real interest rates, and an overvalued dollar—as signals of a permanent reduction in the underlying rate of growth. Germany and Japan, which did not suffer from the same sharp slowdown and benefited from the dramatic appreciation of the dollar, were perceived to have fundamental institutional advantages. Japan, in particular, was held out as the model that the United States should emulate. It experienced a long cyclical expansion and a remarkable asset price boom.

Now it is the United States's turn to enjoy a long cyclical expansion and a remarkable asset price boom. It is Japan's turn to clean up after previous macroeconomic policy mistakes (and, alas, to make some new ones).

We cannot make sensible judgments about fundamental institutions merely on the basis of observations on GDP growth for a few years. Nor can we use the recent behavior of a stock price index. The kind of question we must ask is whether the institutions cause inputs in production to be used efficiently. To answer this question, there is no way around the methods employed in this paper. We must measure stocks of inputs, then compare the inputs with outputs and construct a productivity estimate. The strength of this paper comes from its application of this approach at the levels of the nation, the industry, and the firm. This range of evidence helps clarify the reasons why productivity varies and offers hints about what the relevant institutional weaknesses might be. If one looks just at the level of the nation, it might be tempting to interpret total factor productivity measures as signals about things that people in white lab coats are doing and to think about institutions that will support more spending on R&D. The evidence presented here suggests that an important fraction of the variation in productivity may in fact be due to more mundane differences—the defect rate on an auto assembly line or the speed with which excess capacity is squeezed out of the dairy industry. Variation in these details may in turn be traced back to institutional differences in the competitive pressure that managers face in product and financial markets or to government regulations that keep firms from responding to competitive pressures.

Over time, other pieces of evidence can be added to the picture presented here. The paper takes a preliminary cut at one potentially rich source of evidence, financial market data. A recent paper by Albert Richards shows how this can be done for individual firms.[1] It lends support to the conclusion from this paper that competition in the market for corporate control decisively affects the efficiency with which firms manage their capital investments. The Richards paper, however, also suggests some of the difficulties that arise in any attempt to use the financial market data as a short cut without measuring inputs and outputs.

1. Richards (1998).

Richards compares Dow Chemical, a chemical company based in the United States, with BASF, a roughly comparable chemical company based in Germany. As one would expect if German capital markets are less successful at disciplining managers, the rate of return earned by BASF on its capital investment projects is systematically lower than the rate earned by Dow. Nevertheless, BASF was able to grow at about the same rate as Dow by investing a higher fraction of its income. As one would expect, the market puts a much lower valuation on BASF than it does on Dow. Dow has a total market value (debt plus equity) equal to about 120 percent of sales. BASF has a total market value equal to about 40 percent of sales. But these differences have persisted for decades. As a result, the rate of return earned by investors in the shares of BASF is about the same as the rate of return earned by investors in the shares of Dow. The basic point here is obvious but worth restating. As long as BASF invests a higher fraction of its income and pays out a smaller fraction as dividends, it can perform as well as Dow by the usual criteria. It can grow as fast and offer the same rate of return to equity holders. Yet all the while it can be wasting resources.

This example suggests that the comparison of equity market rates of return offered here needs to be interpreted with some caution. Market returns by themselves cannot answer the basic productivity question that the author raises. At the firm level, one needs to go through the same exercise as the author has done at the national level: measure capital input by cumulating investment, combine that with information about other purchased inputs like labor and materials, and compare the output of the firm with the inputs. In an indirect fashion, this is what Richards does with the available financial data for his two firms.

For citizens of the United States, the consistent and reassuring message that emerges from this paper, and from other evidence like that presented by Richards, is that competition increases efficiency, even competition in financial markets. Nobody likes operating in a competitive market, especially when times are bad as they were in the 1980s. This does not mean that competitive markets are bad institutions. Perhaps the next time that some influential group complains that our markets are too competitive, we will be a little more skeptical. Perhaps we will also take a slightly longer-term perspective and wait to see how persistent the bad times are before recommending fundamental changes in our institutions.

Economists are trained to look for a cloud to go with any silver lining. For people living in the United States, this paper has a cloud as well. As the author points out, the lesson from the Japanese auto industry is not that patient, cheap capital is the key to success. On the contrary, expensive, scarce capital was associated with the development of the lean system of production that gave Japanese producers a lasting productivity advantage. The cheap capital that became available to firms during the run-up in Japanese asset prices led to a substantial reduction in productivity. Let us hope that comparably bad investment decisions are not being made now by firms in the United States, else we may look back on the 1990s and wish that investors had been less patient and had been more focused on short-term performance.

Commentator's Reference

Richards, Alan. 1998. "Connecting Performance and Competitiveness with Finance: A Study of the Chemical Industry." In *Chemicals and Long-Term Economic Growth: Insights from the Chemical Industry,* edited by Ashish Arora, Ralph Landau, and Nathan Rosenberg, 461–511. New York: Wiley Interscience.