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CAPITAL PRODUCTIVITY AND THE NATURE OF COMPETITION

by

Axel Börsch-Supan

Department of Economics, University of Mannheim, Germany
Center for Economic Policy Research, London, UK
National Bureau of Economic Research, Cambridge, Massachusetts

ABSTRACT

This paper measures capital productivity in West Germany, Japan and the United States and links capital productivity to financial performance. We show that West Germany and Japan have significantly lower levels of capital productivity than the United States, mainly due to lower capital utilization but also because less productive capacity was created per unit of physical assets.

On a higher level of causality, we show that this mainly comes from less pressure from product market competition and weaker corporate governance in West Germany and Japan. While external factors such as government ownership and regulation were important, more than half of the productivity gap could in principle have been closed by managerial action.

The lower level of capital productivity in West Germany and Japan explains a large part of the difference in per capita income between these two countries and the U.S. Moreover, the high level of capital productivity in the U.S. generated financial returns that created more new wealth than in West Germany and Japan in spite of the well-known low U.S. saving rates.

ADDRESS:
Prof. Axel Börsch-Supan, Ph.D.
Department of Economics
University of Mannheim
D-68131 Mannheim, Germany
Fax: +49-621-292-5426
E-Mail: axel@econ.uni-mannheim.de

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1. Introduction

While labor productivity is a topic of constant debate and has been studied extensively, far less attention has been devoted to questions about a nation's capital stock.[1] „Capital" actually has two interrelated meanings: physical capital (machinery and buildings) and financial capital (stocks and bonds) which lays claim on physical capital and the income it generates. Capital productivity is the measure of how well physical capital is used in providing goods and services. This paper measures the level of capital productivity in the three leading economies of the world at the aggregate level and in five major industries, and it investigates the causes for international productivity differences.

Productive use of physical capital is an important source of a nation's material standard of living. We find that the difference in capital productivity accounts for more than half of the per capita GDP difference between West Germany and the United States. In addition, how well a nation uses its capital affects the return that people get on the money they save. We find that the U.S. corporate sector generated a rate of return that is between 170 and 200 basis points higher than in Japan and West Germany. This is especially critical because an increasing proportion of retirement income is related to savings. Small differences in the rate of return compound to large differences in retirement income.

Economists are used to frame their analysis of a nation's growth and output level in terms of total factor productivity and capital intensity.[2] We will depart from this convention and reparametrize the analysis in terms of labor productivity and capital productivity. This is helpful because these two measures relate directly to the two tangible factors of production that managers attempt to govern. In particular, the study of *capital* productivity sharpens our focus on a specific aspect of the production process, namely the management of the factor „physical capital." Seen from this perspective, the relation between labor and capital productivity is a complicated one. On the one hand, labor productivity and capital productivity may be negatively correlated because more a higher capital intensity raises labor but lowers capital productivity. This is the conventional economist's view. On the other hand, better management in general may mean better management of all resources, labor and capital. According to this managers' view, labor and capital productivity are positively correlated.

We find strikingly large differences in physical capital productivity across the three economies, both on the market level of the economy and in five industries which we studied in detail: automotive, food processing, electric utilities, telecommunications and retailing. We find that both capacity utilization and the production capacity created by a given amount of physical assets varied systematically across countries. These differences are the more surprising because all three countries have access to the same technology and because we cannot find differences in how managers are skilled.

We find that the nature of competition facing companies in the product market strongly influences the efficiency of the entire production process. This is evidenced in the positive correlation between labor and capital productivity. Moreover, we find that the capital market reinforces product market competition by cutting off funds to unproductive companies only in face of competitive threats. While external factors such as government ownership and regulation were important in determining the efficiency of the production process directly and indirectly through the nature of competition, more than half of the capital productivity gap could in principle have been closed by managerial action.

After detailing our methodology in the following section, section 3 presents our basic results. Sections 4 through 6 are devoted to three hierarchical levels of causality for the observed differences in capital productivities: managerial decisions, industry dynamics, and factors external to managers. Section 7 draws conclusions and implications for national income, financial performance, and wealth creation.

2. Approach and measurement

Our approach to measure and explain capital productivity has two core elements: we compare three countries with each other, and we combine aggregate evidence with causal analyses at the industry level.

The *international comparison* approach allows us to learn from the variation in performance across countries that has been generated by "natural experiments" in the form of their different histories and policy approaches. We selected the three largest economies in the world to study in this report: Germany, Japan and the United States, providing us with an opportunity to examine a broad range of policy approaches and performance.[3]

While aggregate evidence gives us a complete picture of the three nation's capital productivity, the high level of aggregation and a number of approximations make it impossible to have full confidence in the aggregate level measures and impossible to determine the causes for international differences in capital productivity. Thus, we conducted industry case studies to check the aggregate results and to attempt to understand the reasons for the differences in capital productivity levels. We collected industry data from official sources (such as the industry censuses and published industry studies) as well as from a large number of interviews with industry experts in Germany, Japan and the U.S. These industry data are much richer than aggregate data and could be combined with the knowledge McKinsey has accumulated in its industry practice.[4]

The core of our analysis rests on five case studies: automotive, food processing, electric utilities, telecommunications and retailing. We chose these five sectors because they include the most capital-intensive sectors of the economy (telecommunications, electric utilities and retailing). Together, they cover roughly a quarter of the nonresidential physical capital stock in each of the three nations' market sector, see Exhibit A. The cases represent a broad range of sectors: manufacturing (automotive and food processing) and service sectors (retailing and telecom), domestic (retailing, telecom and electric utilities) and traded (automotive) goods, and industries dominated by small companies (retailing and food processing) as well as large companies (telecom, automotive and electric utilities).

Exhibit A=Obj&Appr. 12

Market sector and industry definitions

Our first task was to develop a core set of data on output and capital for the aggregate and the industry level. We restricted the aggregate analysis to the market sector of each economy because there is no meaningful aggregate measure of output, and hence, of productivity for the non-market sector (government, education and health services).[5] We defined the market sector and each industry in a consistent matter across the three countries, excluding nonindustry and auxiliary services, for example, equipment production from the telecommunications service industry.

Output

When meaningful, we used *physical output*, for example kilowatt-hours in electric utilities and call-minutes in the telecommunications industry.[6] In industries in which output is heterogeneous (automotive, food processing and retail) and on the aggregate level, we used *value added* as our output measure.[7] We converted value added into physical units of output by dividing it by sector-specific purchasing power parities (PPP). Ideally, one would like to have a specific PPP for the industry under examination, which compares the unit prices at the factory gate of comparable products across countries in an industry.[8] We constructed such an industry PPP in the automotive industry, weighting individual product PPPs to construct an average PPP exchange rate for the industry as a whole. In other industries and in the market sector, we adjusted the relevant OECD's expenditure PPPs for taxes and distribution margins to compute factory-gate PPPs for the corresponding industries. We used the most recent benchmark PPP comparisons made by the OECD in 1990 and 1993.[9] Because these benchmarks differed slightly, we used an average of the 1990 and 1993 PPPs.[10] Exhibit 1 displays the PPPs used and the resulting value added of the three countries' market sectors.

Exhibit 1=Aggregate, Appendix1

Capital input

The collection of capital input figures is plagued by measurement issues.[11] We did not use national accounting figures of *capital stocks* because accounting conventions differ dramatically across countries. Rather, we accumulated historical investment expenditures and subtracted standardized depreciation for consistent capital stock estimates.[12] In each sector, this „perpetual inventory method" was applied separately to structures and equipment.[13] It is important to standardize depreciation because accounting depreciation differs across countries without any evidence of a corresponding difference in service lives. We applied a „sudden death" depreciation schedule and used the sector-specific service lives computed by O'Mahony (1993) for structures and equipment. The capital productivity differences are insensitive to the choice of the depreciation schedule and to whether shorter or longer service lives are assumed, as long as the same schedule and the same service life is used for all three countries.

Exhibit 2 displays capital stocks in the market sectors of the three countries, measured on a per capita basis.[14] Although the capital stock grew in all three countries, it grew much faster in West Germany and Japan. The U.S. increased equipment stocks more quickly than structures, whereas West Germany and Japan grew their stocks of structures faster. As opposed to national accounting figures, our standardized measure shows that West Germany had a higher per capita level of capital than the U.S. as far back as 1970. This difference grew significantly over the past two decades and only stabilized very recently. In 1995, West

Germany had about 20 percent more capital per capita than the U.S. Because Germany has much less employment per capita, relative capital intensity is even higher (about 140 percent of the U.S. level).[15]

Exhibit 2=Aggregate, Appendix 2

The situation in Japan changed dramatically over the period, since Japan was at a different stage of development from the U.S. and West Germany in 1970. At that time, Japan's per capita amount of structures was less than 40 percent of the U.S. level, and total capital was approximately half. Since then, higher per capita net investment levels in both structures and equipment allowed Japan to surpass the U.S. total level by 1987, reaching almost 140 percent of the U.S. in 1993. However, because per capita employment in Japan is even higher, Japanese capital intensity is lower than in the U.S. (about 85 percent of the U.S. level).

We converted the capital stock to a measure of the *flow of capital services* used in the production process by dividing capital stocks by their service lives, assuming that capital services flows were evenly distributed over the entire life of the capital good. These flows display a pattern that is very similar to the corresponding stocks. German and U.S. flows of capital services are a little closer to each other than the corresponding stocks, while flows are relatively larger in Japan. This is caused by the different composition of the capital stock: West Germany has the highest and Japan the lowest share of structures which have a longer service life and thus a relatively smaller flow of services than equipment.

The value of capital services is converted to *physical units* by dividing structures by the OECD non-residential structures PPP, and equipment by a general equipment PPP that has been aggregated from the corresponding detailed OECD equipment PPPs.

Capital productivity

Finally, *capital productivity* is defined as physical output divided by the physical units of capital services used to generate that output. It is average rather than marginal productivity because we divide all output by all capital services. Our measure of capital productivity varies only slightly from a stock-based measure. The stock-based capital productivity difference between West Germany and the U.S. is a little larger due to Germany's higher proportion of structures and equipment. We believe that the capital-service based measure is better because it more closely approximates actual capital usage.

3. Results: Capital productivity, capital utilization, and capacity creation

Exhibit 3 collects our main results. The five industry case studies and the aggregate analysis consistently show capital productivity in Japan and West Germany to be much lower than in the U.S. In the aggregate, both countries achieved only about two-thirds of U.S. capital productivity.

Exhibit 3=Synthesis 2

The difference is particularly dramatic in the telecom industry, where each unit of capital could generate twice as much output in the U.S. compared to West Germany and Japan. There are only two exceptions from this consistent pattern: automotive production in Japan and retail in West Germany. We believe, however, that our measure overstates German retail performance because we were unable to adjust for differences in the level of service and convenience offered. We will explain this point when we discuss the productivity differences in each industry in more detail.

To structure this discussion, Exhibits 4 through 8 display the components of differences for each of our five industry case studies. We categorize these components into three dimensions: capacity utilization, capacity creation, and subindustry mix.

Capacity utilization

Capacity utilization manifests itself differently in the various sectors. In automotive and food, utilization has two key components: operating hours of the plant and downtime associated with factors such as maintenance and changeovers. In telecommunications and electric utilities, higher utilization comes mainly from greater demand for use of the largely fixed asset network. In retail, store opening hours are the main component of capacity utilization.

Exhibit 4 displays the components of capital productivity differences for the automotive industry.[16] Germany's capital productivity is about one third below U.S. and Japanese level, mostly because of lower capacity utilization. Plant operating hours are between 3,500 and 4,000 hours a year, while they are between 3,800 and 5,600 in the U.S. and Japan. This is only to a small extent due to fewer shifts: the main difference comes from fewer days worked per year and a shorter work day in Germany. In addition, there are differences in downtime due to maintenance and changeovers. While Japanese plants reach an uptime of almost 95 percent, it is less than 90 percent in the U.S. and about 75 percent in Germany. Together, this accounts for a about 25 percent capital productivity disadvantage of Germany, and a 15 percent advantage for Japan, relative to the U.S.

Exhibit 4=(Automotive, page 6)

It should be noted that the figures in Exhibit 4 aggregate over important differences across segments and individual companies. The Japanese auto assembly is actually less capital productive than the U.S. assembly. However, in the aggregate, this is compensated for by a 20 percent capital productivity advantage in the parts segment of the Japanese automotive industry. The variation across companies is also large. As Lieberman et al. (1990) have shown for 1987, GM was even less capital-productive than the German autoindustry, while Ford and Chrysler had at that time already made major productivity improvements, reaching almost Japanese capital productivity levels. The same intra-industry variation held for Japan. In 1987, Toyota had a 15 percent capital productivity advantage over Nissan, 25 percent over Mazda.

A large difference in capacity utilization is also the main components of international capital productivity differences in our other manufacturing industry, food processing.[17] As Exhibit 5 shows, German and Japanese capital productivity in the food processing industry is less than 70 percent of U.S. level. The low capacity utilization in Germany and Japan is due to lower operating time and much more downtime. For example, in the dairy industry the average U.S. plant runs 18.6 hours per day, compared to 13.8 and 11.8 hours in Germany and Japan, respectively.

Exhibit 5=Food 9

In the retail industry, capacity utilization in Germany is reduced due to the restriction on store opening hours.[18] Estimates of this effect are controversial, because little is known about substitution effects. We employed a conservative estimate from a study by the German Ifo-Institute (1995) which implies a 3-5 percent capital productivity disadvantage relative to the U.S., see Exhibit 6. However, this study did not consider second-round effects such as a shift from low to high productivity formats in response to different shopping habits.

Exhibit 6=Retail 7

As opposed to retail, differences in capacity utilization are the major components of capital productivity differences in the fixed asset industries telecom and electric utilities. Exhibit 7 displays the telecom results for 1994, where capacity utilization is defined as the number of call-minutes per access line.[19] While the U.S. had 2,801 local and 418 long-distance call minutes per access line, Germany had 930 local and 401 long-distance call minutes, i.e., 46 percent of the U.S. call volume. In Japan, call volume was 44 percent of the U.S. level. The difference in call volume accounts for the entire capital productivity difference between the U.S. and Japan, and for 70 percent of the gap between German and U.S. capital productivity.

Exhibit 7=Telecom 9

A very similar picture emerges for the capital productivity difference between the Japanese and the U.S. electric utilities industry.[20] As Exhibit 8 shows, almost the entire difference of 51 percent is due to lower utilization of the available generation capacity, (measured as ratio between actual generation and installed capacity), grid capacity (kWh per km of power lines), plus several power plants that were not connected to the grid by 1993. These plants were built because pre-bubble estimates projected a steep rise in the demand for electricity. This demand has not materialized. If these plants would be connected to the grid, generation capacity utilization would drop accordingly.

Exhibit 8=Electric Utilities 13/14

Utilization of the generation capacity is higher in Germany than in the U.S. (50.5 percent rather than 46.5 percent of installed capacity). However, this advantage is more than compensated for by a lower grid utilization (63 percent of U.S. utilization).

Summarizing the results in Exhibits 4 - 8, we find that the slack in capacity utilization accounted for more than 70 percent of the capital productivity gap between West Germany and the U.S., and for almost 60 percent of the U.S.-Japanese gap.[21]

Capacity creation

The second major component of capital productivity is capacity creation, i.e., the amount of production capacity that is created per unit of physical assets invested. There a two facets of this component: one can build a given plant capacity (e.g., kilowatt-hours of a power plant) with more or fewer assets (e.g., thickness of concrete walls), and, conversely, one can operate the same assets more or less efficiently to generate more output. Both effects are seen in the lean production system in the auto case. Using simple machines lowers the capital requirements per line, while higher quality output and fewer defects increase net output per line. Ironically, the significant increase in automation and the other capital between 1987 and

1993 in Japan significantly raised the capital used per unit of production capacity, fully offsetting the Japanese advantage in higher capacity utilization (Exhibit 4). In Germany, capital was spent on asset features such as very high precision that could not be justified by additional value for which customers would actually, again raising capital used per unit of production capacity, measured in value added terms.

In the food processing industry, Japanese companies spent more assets in logistics and distribution per unit of products, and Germany wasted assets in imbalanced production lines and other operational practices that penalized German productivity by about 10 percent vis-à-vis the U.S. (Exhibit 5)

Maximizing the capacity created with assets was most critical in the retail case, see Exhibit 6. Capacity creation has two facets: the value added per volume unit of goods sold, and the throughput in terms of volume units of goods sold per capital services used, see Exhibit 9.[22] In general, U.S. retailers achieved high capital productivity by offering more service than retailers in Germany and by increasing the value that they add for each good that they sell. German retailers, on the other hand, achieved comparable productivity just by minimizing capital input: they use much less floor space than do U.S. firms to generate comparable sales. Higher throughput per unit of assets gave the German retail industry an advantage of about 15-20 index points relative to the U.S., while Japan with even less throughput lost further 15-20 index points vis-à-vis the U.S.

Exhibit 9=Retail 6

The distinction between value added per unit of throughput and throughput per unit of assets also reveals a severe measurement problem in evaluating retail productivity. Because we were unable to adjust for differences in the level of service and convenience offered, we believe that our measure overstates German retail performance. Because we have no physical measure of retail services, we divided value added by the consumer goods PPP. This PPP lumps price differentials in the goods themselves together with price *and* quality differentials in the services attached to the goods sold by the retail industry. The fact that the German retail „model“ is not being transported to other countries (unlike most other „best practice“ ideas) supports the contention that the true value added is actually lower than displayed in Exhibits 3 and 6.

Fewer access lines per unit of total assets in the German telecom industry reduced German capital productivity by almost 20 index points. Japan, in turn, used about the same amount of capital per access line as the U.S. (see Exhibit 7).

Power generation in the German electric utility industry yields another example for „goldplating,“ i.e., using capital for features that cannot be turned into higher value products for which the consumer actually pays. However, this is offset by a more efficient grid design, partially due to a more advantageous geography as compared to the U.S. and particularly to Japan, permitting the transmission of more kilowatt-hours per grid-kilometer (see Exhibit 8).

Mix of subindustries

In some of our case studies, the subindustry mix is different across countries. Germany, for instance, has more nuclear power plants than the U.S. and Japan.[23] Japan's seafood industry is a disproportionately larger part of its food processing industry.[24] As it turned out, however, in no case did the mix of subindustries affect the capital productivity differences for the overall industry studied. In the food case, relative productivity rankings were similar across many different food categories such as bakery, meat and dairy. The results in the electric utility case, on the other hand, differed significantly by plant type. For instance, nuclear plants were far more capital productive in Germany than in the U.S., while the reverse was true for fossil fuel plants.[25] These differences happened to offset each other, such that the subindustry mix evolved as an unimportant differentiator overall.

Causal analysis

The large differences, both in capacity utilization and in capacity creation, are surprising because we have no reason to believe that managers in one country are any more skilled, or have acted any more rationally, than in another country. Rather, we will show that they have responded consistently and predictably to the pressures and incentives placed upon them by their environments. Productivity differences across countries arise because economic systems create different dynamics of innovation, improvement and creative destruction.

Our argumentation proceeds in a hierarchical sequence of causal factors, see Exhibit 10. At each level of the hierarchy, we take the causal factors as exogenous but endogenize them at the next higher level of the hierarchy. First, we look at firm-level managerial decisions, for instance, how effectively managers use marketing. On the second level, we investigate how positive industry dynamics have created pressure on managers that lead them to improve performance. We are specifically interested in the interaction of product and capital market forces on shaping managerial decisions. On the third and highest level, we scrutinize how external structural factors in each economy have affected the intensity of these forces. Our main hypothesis is that the degree of product market competition was the result of external factors such as regulations that interfered with the market both by creating barriers to entry and by constraining how competition took place.[26] Differences in the capital markets, such as the identity of the owners and the functioning of the market for corporate control, may also have influenced industry dynamics by setting performance goals for managers and reallocating capital among firms.

Exhibit 10=(Synthesis 5)

Exhibit 10 displays the framework for our causal analysis and highlights those factors that are of primary and secondary importance in explaining the differences in capital productivity. The framework is motivated by enforcing discipline in constructing and analyzing causal factors that are mutually exclusive and collectively exhaustive to the extent possible. Primary causal factors explain at least a third of the difference in capital productivity between at least one country and the best performing („benchmark“) country, secondary causal factors at least 10 percent.

4. Managerial decisions

The relative productivity differences are the result of the different ways in which managers run their businesses in the three countries. The two most important management functions are marketing and operational effectiveness because they affect both capacity utilization and capacity creation. We will assess each managerial factor separately.

Marketing

We refer to marketing in its business context; that is, how a company understands the needs of its customers, develops and prices the appropriate products/services to meet those needs, and then determines the appropriate channel to reach its customers. Marketing is said to be effective if these services create a value for which the costumer is willing to pay.

In four out of five of our case studies, effective marketing explained at least a third of the observed capital productivity differences.[27] Marketing, particularly via pricing and product-line management, affects capital productivity in three key ways.

First, managers raised capacity utilization in the telecom and electric utilities industries both by increasing demand and dampening its volatility. In U.S. telecom, new product introductions such as answering devices and call-waiting service, flat rate pricing, and low price levels relative to other goods and services stimulated higher levels of demand over the largely fixed asset base. This resulted in higher utilization. Exhibit 11 shows that 35 percent of U.S. calls are generated by flat pricing, and that Germany could increase call minutes by 36 percent, Japan by 12 percent based on a conservative price elasticity estimate derived from Meyer (1980) and Taylor (1979).

Exhibit 11=Telecom 11/12

In electric utilities, innovative pricing structures, such as time-of-use pricing, have proved effective in both the U.S. and Germany in reducing demand at peak time periods. As a result, depicted in Exhibit 12, demand is much less volatile than in Japan and average capacity utilization rises.

Exhibit 12=Electric Utilities 15/16

Second, effective product-line management can boost productivity by reducing the downtime associated with product-line changeovers. In the Japanese food industry, for example, extreme product proliferation lowered machine utilization, see Exhibit 13. Because Japanese manufacturers used product variety as a key variable on which to compete, as much as 50 percent of one year's products were not offered the next year, increasing costly changeovers.[28] In contrast, world-class manufacturers, including some in Japan, avoided this product churning through the use of market research which helped to make a better trade-off between product variety and plant utilization.

Exhibit 13=Food 12

Third, and most broadly, by segmenting the market and tailoring products and services to meet the specific needs of a particular niche, companies could increase the value added they generated relative to the assets employed. This is particularly evident in the retail industry. The U.S. retail sector has created a wide variety of stores with different mixtures of value and volume („format“): from upscale specialty stores (high value added, low sales volume) to steep discounters (low value added, high sales volume), see Exhibit 14.[29]

Exhibit 14=Retail 9

Because marketing actions affect consumer behavior, their impact on productivity often manifests itself only in the long run, as the telecom case shows. The high level of call volume per capita in the U.S. is the result of a long history of pricing decisions and product introductions that have encouraged people to incorporate the phone into their daily social and business interactions. We, therefore, attribute the resulting demand and productivity differences not to variations in „culture“ but to differences in behavior that have been primarily influenced by marketing.

Operational effectiveness

The way in which firms organize and operate their plants, stores and networks is the second critical factor in explaining capital productivity differences across countries. Operational effectiveness affects capital productivity in several ways. Better practices improve utilization by lowering machine downtime. This is most evident in manufacturing industries like auto, in which downtime was an important driver of productivity levels. On average, Japanese producers, via lean manufacturing practices, set up faster during changeovers and stop machines for less time to fix process problems.

In addition, good operating practices increase the effective capacity of a line for an existing set of assets. Again, the auto industry illustrates the point. Japanese manufacturers, via better design for manufacturability as well as their continuous improvement („*kaizen*") approach, simultaneously reduce the number of production steps and lower the defect rate (Exhibit 15). This yields higher net output per line both because less capital time must be devoted to rework and because consumers recognize, and will pay for, the resulting higher quality and reliability.

Exhibit 15=Auto 15

Finally, operational practices increase productivity by requiring less capital for each process step or function. The German retail industry, which generates much higher sales volume per square foot than its counterparts in both Japan and the U.S., is a good example, as we had seen earlier.

Capital expenditure decision making

Capital expenditure decision making was an important causal factor for the lack of capital productivity in Germany, much less so in Japan. It comprises how managers make decisions about how much capital to employ and what kind of assets to put in place. Capital planning processes and the spending decisions made as a result have a direct effect on capacity utilization. These decisions can take the form of building new plants that are not necessary (utilities in Japan, Exhibit 8), not eliminating existing capacity that is underutilized (food in Germany, Exhibit 5) or failing to reconfigure assets to free up hidden capacity (telecom in Germany has provided huge ISDN capacity which is not being used efficiently; similarly, there is much hidden capacity in the Japanese fiber net).

Inefficient asset choice was prevalent among German managers who choose to spend additional capital on asset features or functions that could not be justified by additional value for which customers would pay („goldplating“). Goldplating directly increases the amount of assets for a given level of capacity. In the auto industry, German producers in many instances "overengineered" their processes and built in higher levels of precision than tasks required.[30] Other examples in the German telecom and electric utility industries were discussed above (see Exhibits 7 and 8).[31]

Goldplating – unnecessary large quantities of capital – is to be distinguished from high capital expenditures due to unnecessarily high prices for capital goods. In our measures of physical capital productivity, we removed the effects of pure price differences in the cost of investment goods. While this helps to isolate purely operational differences, it ignores that there are substantial opportunities for corporations in Germany and Japan to pay less for their equipment, thereby improving financial performance. Capital equipment PPPs were on average 48 percent and 67 percent higher than the market exchange rates in Germany and Japan, respectively. Because most equipment is tradable, unlike to many consumption goods and services, these price differentials are striking. In fact, our interviews revealed frequent managerial biases toward locally-produced equipment in both Germany and Japan. These biases are often not justified by barriers to global sourcing, rather, managers were either unaware of lower cost alternatives or were willing to pay more due to long-time relationships with local suppliers. Examples were Deutsche Telekom in Germany, where insistence on overly precise specifications had created an unnecessary bias toward local suppliers, whose prices were sometimes 60 percent above the international rate. German auto manufacturers have recognized the opportunity to reduce costs and have moved to more global sourcing in the last several years. Only in some cases was it justified to purchase locally at higher prices. For example, in food processing in Japan, we found that at least some of the local price premium was offset by subsequent cost savings due to local servicing and parts availability. In auto, required safety standards add about 10 percent to the average cost of machinery used in Germany, even if imported.

Industry chain management

Industry chain management refers to the upward and downward linkages in the chain from raw material to end product. Efficient industry management eliminates unnecessary interim steps; we measure the efficiency of one company by comparing it to how other companies have created higher or lower value added with different industry chain structures.[32]

Inefficient industry chain management reduced Japanese capital productivity, but was not a major problem in Germany. Integrating operations with downstream and upstream suppliers tends to improve the efficiency of the whole chain , yielding higher productivity for all participants. For example, a best practice discount store such as Wal-Mart has eliminated intermediaries, simultaneously reducing capital and labor costs, while creating better information flows that allow more effective merchandising. Most Japanese retailers and manufacturers are burdened by Japan's multilayered distribution system.[33] However, the success of some Japanese firms in managing distribution shows that it is in the managers' power to overcome these difficulties. For instance, the Japanese auto industry has improved capital productivity by making the management of its suppliers a critical part of its lean production system.

Production technique

The choice of production technique, surprisingly, was not a differentiating factor in most of the case studies. In most industries, firms had access to the same technology, used similar production processes, and had comparable scale. Choice of production techniques emerged as important only in the auto industry, in which Japanese manufacturers in the late 1980s and early 1990s heavily substituted capital for labor via automation, significantly lowering capital productivity and offsetting other operational advantages.

5. Industry dynamics

Managers make their operational decisions in an environment characterized by the extent and nature of competition in product and input markets. In a competitive market the interaction of product and capital market forces creates a self-reinforcing process that pressures managers to innovate or improve performance. Ideally, the process works as described in Exhibit 16.

Exhibit 16=Synthesis 12

The extent to which this process is able to function largely explained the international differences in capital productivity that we observed. This beneficial cycle of performance improvement is evident in the U.S. retail and food processing industries. In these relatively fragmented industries, complementary product and capital market forces boosted capital productivity by allowing consolidation to occur (in the U.S. food industry) by allowing innovation to spread rapidly (in the U.S. retail industry).

As summarized in Exhibit 10, three factors in this self-reinforcing process emerge as most important in explaining the international differences in managerial decisions: the intensity and the nature of competition in the product market; differences in corporate governance, specifically differences in managerial goals and the degree to which they are aligned with productivity; and the varying extent to which the capital market cuts off funding to inefficient players. Labor market factors turned out to be of minor significance, an important finding in the light of potential capital-labor substitution.

Product market

In each of the nonmonopoly industries, the intensity and the nature of competition in the product market was critical in explaining performance. The most dramatic example is the retail industry, which shows a dynamic of creative destruction. In the U.S. market, many of the most productive players today are relatively new ones that have grown quickly. Unproductive players and formats have largely been eliminated from the market. Less dynamism marks the German and especially the Japanese markets, see Exhibit 17.

Exhibit 17=Retail 18

The food industry also highlights the importance of forcing out inefficient players. Open competition in the U.S. forced consolidation of the industry, which improved industry-wide utilization. Lower levels of competition have prevented this from happening to any significant degree in Japan, and initially slowed the process in Germany. The resulting distribution of large, medium, and small establishments is depicted in Exhibit 18. As can be seen, there are not only more large establishments in the U.S. than in Germany and Japan. In addition, the productivity advantage of large U.S. establishments relative to smaller plants is larger than in the two other countries.

Exhibit 18=Food 19/20

The auto industry demonstrates the importance of product market competition at the international level by forcing existing players to improve. Intense competition in the Japanese market fueled the diffusion of Toyota's innovative production system within Japan. However, U.S. and German producers were slow to innovate because high capital intensity and scale requirements in the assembly part of the industry created high barriers to entry and exit. Productivity has improved only after they were faced with the threat of the Japanese producers themselves. The more rapid adoption of Toyota's lean production methods in the U.S. and faster productivity growth relative to German can be explained largely by the fact that U.S. firms were exposed to the competitive threat posed by Japanese producers both much earlier and to a much greater degree.

Capital market

The intervention of capital market forces affects industry dynamics by pressuring managers to perform and by reallocating capital among players based on performance. We observed wide differences in performance pressure on managers across countries. Not surprisingly, low productivity resulted when basic managerial goals, for example sales growth, did not focus managers' attention on how productively they were using their assets. Of course, having productivity itself as a primary goal would be extremely effective. The lean production system of Japanese auto producers illustrates the benefits of such an approach. However, we did not observe any other such example. In turn, a focus on financial performance, especially prevalent among U.S. firms, did create a clear performance objective that was generally aligned with productivity. Intuitively, in a competitive market many of the actions taken by managers to improve financial returns should also improve capital productivity. More profits come from increasing productivity, and in the long run, an objective of profit maximization results in higher productivity. Raising capacity utilization and reducing the amount of „goldplating" are obvious examples.

Exhibit 19=Synthesis 13

Our empirical findings support this contention that financial performance is correlated with capital productivity in competitive markets. In most of our cases, we see that the difference in financial returns between the U.S. and Japan is very similar to the gap in productivity performance (Exhibit 19). Even within one sector in the same country, U.S. retailing, there is a high correlation between capital productivity and financial return, as evidenced by more productive formats earning higher returns and creating more shareholder value (Exhibit 20).

Exhibit 20=Synthesis 14

Physical capital productivity is also mirrored in financial capital performance on the aggregate level. Over the 1974 to 1993 period, U.S. financial performance was significantly better than in Germany, and on average better than in Japan. We calculated financial performance by relating the payouts from the corporate sector (interest, dividends and capital gains) to the inflows into the corporate sector (debt and equity) through the corresponding internal rate of return, including the initial and final stock of financial wealth.[34] For the 20 years between 1974 and 1993, the annualized aggregate rate of return was 9.1 percent in the U.S. compared to 7.4 percent in Germany. U.S. rates of return also exceeded Japanese returns on average. For the 1974 to 1993 period, Japanese returns were 7.1 percent. These estimates are robust to changes in definition and computation period for the U.S.-German comparison, while 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. However, in all time periods that we think are meaningfully comparable, the U.S. has a higher rate of return than Japan.

Another mechanism that creates a positive correlation between capital productivity and financial performance is that a competitive capital market cuts off funding to inefficient players and thus forces restructuring or exit. However, this mechanism turned out as one of secondary importance because in many instances the capital market only acted after the poor performance in the product markets had already destroyed much of the economic value of a business.

In both the food and retail industry, a greater willingness to let firms die expedited the entry and exit dynamic described above. This restructuring occurred in two ways: a higher degree of bankruptcies and greater mergers and acquisitions activity in the U.S., as was shown in Exhibits 17 and 18. However, in all three countries corporate governance failed to apply pressure effectively until firms were close to running out of cash. In the retail case, we saw examples in all three countries in which firms were allowed to continue earning well below their cost of capital for long periods of time without dramatic intervention. Examples of even greater value destruction took place in the auto industry (General Motors in the U.S., Daimler Benz in Germany).

This correlation between productivity and financial performance is clearly not perfect. For instance, it is broken in product markets with low competitive intensity. For example, a monopoly such as Deutsche Telekom has low productivity but high profitability via the ability to sustain high prices. Trade protection in the mid-1980s in the U.S. auto industry allowed the industry to earn profits despite low productivity. The capital market itself can also introduce 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. In spite of these distortions, the link between productivity and financial performance holds for the economy as a whole. We will discuss this in more detail in section 7.

Labor market

Labor market factors such as the availability and cost of labor were not generally important factors in explaining capital productivity differences. The only significant exception is the Japanese auto industry. A perceived scarcity of labor in Japan due to population aging precipitated overinvestment in automation which significantly reduced capital productivity. Labor costs also had some influence in the food and auto cases, because they raised the premium required for third-shift work, primarily in Germany. Quantitatively, this turned out to be of lesser importance because there were many other factors that contributed to lower capacity utilization. The general insignificance of labor market factors is surprising as one might argue that capital-labor substitution lowers capital productivity in favor of higher labor productivity throughout an entire country in which labor is relatively expensive. We will come back to this point in section 7.

6. External factors

External factors, like regulation in product and input markets or the macroeconomic environment, are a critical part of the causality story because they shape the industry dynamics and have a direct impact on managers' actions. As Exhibit 10 has summarized, two factors are particularly important: regulation – both in form of product market regulation and monopoly regulation – and ownership.

Product market factors

Product *market regulation* critically influences capital productivity by limiting competitive intensity and affecting the nature of competition. Regulation creates barriers to entry, limiting the transfer of best practice as well as reducing performance pressure. For instance, zoning regulations and licensing practices limit market entry in the retail sector in Japan, protecting inefficient mom-and-pop stores. In the auto industry, trade protection (mainly via voluntary restraint agreements) prevented highly productive Japanese manufacturers from making further inroads in the U.S. and European markets.

Product market regulation also limits the options that managers have in setting strategy. For example, zoning regulations in Japan more severely restrict managerial choice in location decisions than in the U.S. and West Germany. By limiting the amount of competition, these regulations can also have the side-effect of distorting the correlation between productivity and financial performance. For example, the voluntary restraint agreements employed in the U.S. to restrain Japanese auto imports provided a short-term window for U.S. manufacturers to raise prices, thereby boosting profitability but not productivity.

Effective *monopoly regulation* creates incentives for managers to use their resources productively and can, within limits, substitute for the discipline enforced by p[roduct market competition. In the U.S. telecommunications and electric utility industries, monopoly regulation took the form of tight price control which had two effects. First, rate-of-return regulation with prudence reviews forced managers to justify cost increases under great scrutiny. Second, price cap regulation created the incentive to be more productive because owners could keep productivity gains as profit. However, in both Germany and Japan regulators did not focus on price. Rate-of-return regulation without price controls created an incentive to waste resources because German and Japanese managers were allowed to charge the more, the more they had spent.

Capital market factors

Ownership turned out as the most important factor in explaining why managerial goals were not aligned with productivity and why inefficient players did not disappear. The clearest example is government ownership, as seen in the utility and telecom industries. In Germany, for instance, the government, as both owner and regulator of Deutsch Telekom, had many 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 no clear objective function for managers and provided little direct pressure on them to use resources productively.

We also found widely varying goals among private owners. Some focused on goals such as stability and prestige that did not encourage the productive use of assets. Different ownership structures also affected the likelihood and pace of restructuring. We have already mentioned examples in several areas (Exhibits 17 and 18): Japanese retail conglomerates cross-subsidized underperformers; cooperative ownership in the German food industry retarded industry consolidation; and privately held share ownership in the German retail industry reduced the pace of industry restructuring via mergers and acquisitions.

Secondary external factors

Other external factors, such as the *macroeconomic environment*, have been important in only one country or in individual industries, but their impact across all of the case studies was of secondary importance. The impact of the „bubble economy" in Japan affected industry dynamics in three distinct ways. First, the high cost of land created by the bubble created artificial barriers to entry in the retail industry. In addition, as discussed, retailers focused on speculative land acquisition in Japan which distracted their attention from 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 where overautomation was done in part because capital was readily available and perceived to be almost costless.[35] 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.

Differences in the *sources of funding* and the *market for corporate control*, along with ownership issues, are the reason that capital market players are sometimes less willing to cut off inefficient players. In Germany and Japan, there is a greater reliance on bank lending as a source of capital. Banks, which may have long-term relationships and significant loans at risk, are more willing to continue providing funds to a less efficient firm as long as it can meet interest payments. This effect is diminished in the U.S., where easily tradable securities are the primary source of financing. In addition, higher levels of mergers and acquisitions in the U.S., due both to legal differences as well as the "sophistication" of the M&A industry, forced restructuring in some cases. This mattered particularly in consolidating industries with excess capacity like food processing, and in inefficient segments of a market, like department stores in retail.

New entrant financing, via the venture capital industry for example, did not appear to be differentially important in our five industry case studies. However, our sample was not representative in this respect because it did not include industries where start-up capital may be especially important such as biotechnology or software.

Distribution chain dynamics external to the specific industry were only a secondary factor that shaped differing levels of product market competition. The success of some Japanese firms in establishing an efficient distribution system demonstrates that the complexity of the Japanese distribution system is not entirely insurmountable. Nonetheless, in the food processing and retail industries in Germany and Japan, the complicated distribution system serves as a barrier to entry, especially for foreign producers. This is particularly true in food processing, in which manufacturers face complexity in both the supply of their raw materials from farms, and in the distribution of their products.

Other factors that are often cited in the business and economics literature or the popular press did not play important roles in differentiating performance levels. For example, *demand differences* had any impact in only two cases. In utilities, structural differences such as weather patterns and the size of houses, had some impact on both demand levels and volatility, and therefore utilization. In the Japanese food industry, perceived customer requirements for freshness and variety lowered capital productivity. But on close examination, these „tastes“ proved to have been shaped by the manufacturers’ behavior. They were not immutable cultural differences, as the high performance and lower product variety of Japanese food processors like Ezaki Glico demonstrated.

We also found no evidence to suggest that differences in *labor skills* were important in explaining productivity differentials. And as discussed earlier, the *demographics* of labor supply in Japan created a perception of an impending labor shortage and fueled automakers' decisions to invest heavily in automation. However, in no other industry did demographics emerge as an factor that had caused international differences in capital productivity.

Role of external versus internal factors

An important question is how these external factors actually precluded or constrained managers from reaching best practice productivity levels, and how much of the observed differences in capital productivity could have been reduced by managers in spite of external obstacles. To answer this question, we classified the specific capital productivity differences that were displayed in Exhibits 4 through 8 in three different categories. First, external factors directly affected productivity and represented a clear obstacle that managers could not overcome. The requirement to put telecom cables underground in Germany is a clear example. Second, on the other extreme case, external factors did not play a role at all and managers could have clearly increased productivity if they had wanted to. The reduction of goldplating is an obvious example. Third, there is a gray area between these two extremes, in which external factors created a hurdle for managers that made it more difficult for them to raise productivity. For instance, high third-shift wage premiums in Germany lowered the economic feasibility of raising utilization with around-the-clock operations, and the fragmentation of upstream and downstream markets in Japan raised logistics costs for food processors. In these gray-area cases, we assessed the extent to which the hurdles could be overcome by managers, based largely on whether or not individual firms in each economy had actually overcome these constraints. If we could not make this determination, we used the full range of the impact of that specific factor to indicate our uncertainty such that our result represents both a minimum as well as an upper bound of how much of the productivity gaps managers could have closed in their current environment.

Exhibit 21=Synthesis 16

Exhibit 21 presents (necessarily rough) estimates of the part of the productivity gap with respect to best practice that managers could have closed, and the part that was external to managers' action. On average across the five industry case studies, we judge that less than half of the productivity difference is attributable to exogenous factors that directly affect productivity. This is an important finding as it implies that managers in Japan and Germany could achieve performance close to U.S. levels by changing things that are already under their control. This does not mean that regulation as the most important external factor does not matter. For instance, the U.S. regulation of the telecom and electric utility industries, by using prices as instruments, lead to higher capital productivity than the regulation chosen by the German and Japanese governments.[36] However, managers could have considerably improved capital productivity in Germany and Japan even within the given regulatory environment.

7. Summary and conclusions

Our five industry case studies and the aggregate analysis showed that capital productivity in Germany and Japan was significantly below capital productivity in the U.S. For the period 1990-1993, market sector capital productivity in Germany and Japan was only about two-thirds of the U.S level. The weighted average of our cases gave a similar result. Only in the Japanese auto industry and, as measured, in German retail was capital productivity at par with the U.S.

In our causal analysis, we showed that managers have responded consistently and predictably to the pressures and incentives placed upon them by their environments. Productivity differences across countries arose because economic systems created different dynamics of innovation, improvement and creative destruction. In particular, positive industry dynamics, forged by the interaction of product and capital market forces, have created pressure on managers that lead them to improve performance. By forcing focus on financial returns, the capital market created a clear incentive for managers to use their resources productively. Open competition in the product market allowed financially successful firms to enter and grow. The capital market facilitated further change by cutting off funding to the inefficient players. External structural factors in each economy affected the intensity of these forces.

The degree of product market competition was the result of external factors such as regulations that interfered with the market both by creating barriers to entry and by constraining how competition took place. In addition, differences in corporate governance, such as the identity of the owners and the functioning of the market for corporate control, also influenced the dynamics by setting performance goals for managers and by reallocating capital from weaker to stronger firms.

In drawing conclusions, we first investigate whether there was a trade-off between capital and labor productivity, and how important the capital productivity differences were in explaining the still substantial per capita income differences across the three countries. We then pick up the argument that capital productivity drives financial performance. We argue that this invalidates claims of U.S. „short-termism.“ Finally, we show that higher capital productivity, through a higher financial rate of return, is an important ingredient in resolving the puzzle why the U.S. has created more new wealth in spite of low saving rates.

Capital/labor trade-off

While capital intensity has risen over time in all three countries, Germany has significantly more capital per worker than the U.S., and Japan has slightly less than the U.S. These differences might reflect different trade-offs between capital and labor, with the associated trade-offs between capital and labor productivity, to achieve the highest possible output for a given total input level. Exhibit 22 shows that this does not appear to be the case. Capital and labor productivity is positively, not negatively correlated across our five case industries.

Exhibit 22=Synthesis 10

Also on the aggregate level, higher capital productivity did not come at the expense of lower labor productivity. This is depicted in Exhibit 23. The U.S. had higher capital productivity as well as higher labor productivity than Germany and Japan, and Japan had lower labor productivity as well as lower capital productivity than Germany and the U.S. The right chart of Exhibit 23 fits a simple Cobb-Douglas production function to our total factor productivity estimate and the observed capital and labor shares.[37] This chart demonstrates that the U.S. was able to create more output than Germany at any level of capital intensity, and Germany more than Japan. Germany and Japan cannot make up for overall productivity lower than the U.S. simply by adding more capital. While international differences in the cost of capital relative to the cost of labor may explain that capital intensity was higher in Germany and Japan, driving these two countries into diminishing returns of capital, diminishing returns do not fully explain the differences in capital productivity.[38]

Exhibit 23=Synthesis 17

Our causality analysis in the industry case studies explains these empirical findings. The cases demonstrate that many of the managerial actions that drive capital productivity also drive labor productivity in two ways. First, some practices primarily raise output and have little effect on the required labor or capital. For example, practices in the auto industry that reduce downtime increase output for a given set of workers *and* capital. Retailers raising value added by tailoring their services to specific customer segments are another example. Second, some practices have the simultaneous effect of reducing capital and labor requirements. For instance, design for manufacturability reduces the number of different steps in the auto assembly process, so fewer worker hours and less capital services are required per car. The prevalence of practices with dual benefits helps explain why total factor productivity in the U.S. is higher.

In addition, there are cases in which simply is no trade-off between labor and capital productivity. The clearest and most important example is the management of capital which explained Germany's poor performance. Goldplated or underutilized equipment in Germany raised capital intensity, lowered capital productivity but did not improve labor productivity.

Market sector GDP

Exhibit 24 summarizes capital and labor productivity at the aggregate level and relates them to value added in the market sector. In Japan, the combination of both significantly lower capital and labor productivity kept output per capita in the market sector substantially below the U.S. level, in spite of a much higher input of labor and capital services.

Exhibit 24=(Executive Summary 1)

In Germany, the combination of low capital productivity and low employment kept output per worker below the U.S. level, in spite of higher capital input and a labor productivity that is close to U.S. levels. Because German total factor input is 91 percent of the U.S. level, and German total factor productivity 88 percent, where the difference comes entirely from capital productivity, slightly more than half of the per capita market sector GDP gap is explained by capital productivity.

„Short-termism"

We found that physical capital productivity was mirrored in financial capital performance. For the 20 years between 1974 and 1993, the annualized aggregate rate of return was 9.1 percent in the U.S. compared to 7.4 percent in Germany and 7.1 percent in Japan. The fact, that over the last two decades financial returns have been markedly higher in the U.S. than in the other two countries, invalidates claims made in the sometimes heated discussion about the U.S./UK-style „outsider" model of capital allocation versus the „insider" model prevalent in Germany and Japan. These claims say, that the U.S. capital allocation system is too focused on short-term financial performance and that long-term U.S. economic performance suffers as a result. This contention is inconsistent with the long-run U.S. financial performance and in particular with the high productivity levels achieved in the U.S. In addition, the frequent view that firms' excessive concentration on their own financial performance impairs economic performance for the country as a whole, appeared not to be true. Rather, by focusing on financial results, firms have a clear performance objective. This objective was a critical factor in explaining productivity differences in our cases. Finally, we found that a purported „long- term" perspective does not necessarily lead to the most productive investments, as evidenced by Deutsche Telekom.

Wealth creation

The high level of capital productivity in the U.S. explains the apparent paradox that the U.S. could save and invest less during the recent decades and still accumulate more new wealth. Exhibit 25 shows that between 1974 and 1993, per capita gross business investment was about 20 percent higher in Germany and Japan than in the U.S. At the same time, the U.S. created about 20 percent more new domestic financial wealth than Germany and Japan.

Exhibit 25=(Financial Performance 21)

While the international differences in today's wealth levels are largely still an implication of the historical wealth differences – in 1970, per capita financial wealth in Germany was only 60 percent, in Japan only 30 percent of the U.S. level – the creation of more new wealth in the U.S. since then is largely attributable to the superior rate of return. Multiplying the actual investments from 1974 through 1993 with the average rate of return in each country yields accumulated capital incomes that are very close to the actual creation of new wealth. This admittedly rough calculation shows the importance of capital productivity in the creation of new wealth. This aspect is increasingly important due to the increase in retirement income that is invested in the capital market.

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Footnotes:

[1] The literature on international and intertemporal productivity comparisons is vast and will not be comprehensively reviewed here. Most work has been done to measure *levels and growth of labor productivity* both at the aggregate and the industry level. For a recent survey, see Gersbach (1997). For manufacturing, van Ark and Pilat (1993) compiled a comprehensive set of productivity figures for Germany, Japan and the U.S. based on the industry-of-origin approach, McKinsey Global Institute (1993) and Baily and Gersbach (1995) based on factory-gate PPPs. More recent estimates appeared in Pilat (1996), including some service industries, O'Mahony (1996), and Freudenberg and Ünal-Kesenci (1994) for France and Germany. The articles in Griliches (1992) describe the difficulties in measuring service sector output. McKinsey Global Institute (1992) and Baily (1993) provide productivity level estimates for selected service industries.

The other strand of literature that is voluminous investigates the *growth of total factor productivity*. 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.

However, there is much less work on TFP *levels*. Conrad and Jorgenson (1995) and Jorgenson, Kuruda and Nishimizu (1987) show aggregate and sectoral TFP levels in Germany, Japan and the U.S. up to 1979. Dougherty and Jorgenson (1996) provide TFP-level estimates up to 1989.

Capital productivity estimates are of course implicit in TFP and in studies that address labor productivity together with capital intensity. However, these implicit capital productivities are rarely reported as separate figures. 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. The TFP-level estimates by Dougherty and Jorgenson (1996) can also be converted in capital productivity levels for Canada, France, Germany, Italy, Japan and the UK as percentages of U.S. capital productivity. Capital productivity levels are explicitly presented in Freudenberg and Ünal-Kesenci (1994) for France and Germany.

[2] The tradition follows Solow (1957). See also Kendrick (1991) for a discussion.

[3] While the international comparison gives us much leverage to identify, e.g., the effects of regulation on capital productivity, it allows only an identification of relative productivity. For instance, when we find that the U.S. electric utility industry is more efficient in terms of capital productivity than the industry in Germany and Japan, this does not necessarily mean that the U.S. is at the efficient frontier. In other words, while the U.S. electric utility industry may have ample room to improve capital productivity, e.g., by strengthening IPPs, the industry performs even worse in Germany and Japan.

[4] While many of the industry studies used are public (and quoted in the sources below each exhibit), benchmark studies performed by the McKinsey's industry practices are confidential. The McKinsey team also visited plants, conducted interviews, and compared capital expenditures for comparable plants. See McKinsey Global Institute (1996) for details on interview findings. In order to insure their representativity, the industry interviews were then cross-checked with the McKinsey industry practices as well as with industry data (e.g., capacity utilization, capital expenditures, pricing etc.). See the Comments and Discussion section of the Baily and Gersbach (1995) paper for a discussion of validity and replicability issues related to this kind of data sources.

[5] However, on the very micro level, international productivity levels of treating a group of single diseases have been measured by McKinsey Health Care Practice (1996).

[6] Figures were drawn from the manufacturing censuses in the three countries (Germany: Statistisches Bundesamt; Japan: Economic Planning Agency; U.S.: Census of Manufacturing). Several adjustments were made to match national accounting data (see next footnote) and to be consistent across countries. See McKinsey Global Institute (1996).

[7] Based on the Detailed Tables in the OECD National Accounts, OECD (1996).

[8] There is now 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 paper by van Ark and Pilat (1993) and Baily and Gersbach (1995).

[9] The sectoral results are published in OECD (1992, 1996). We used the EKS scheme for the three countries involved to aggregate the sectoral PPPs to the market level.

[10] More precisely, we applied the appropriate deflators between 1990 and 1993 to the 1990 benchmark prices to obtain an estimate of the 1993 PPP, and averaged this estimate with the 1993 PPPs reported by the OECD.

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

[12] For Germany: Statistisches Bundesamt, Volkswirtschaftliche Gesamtrechnungen, Fachserie 18; for Japan: Economic Planning Agency, National Accounts; for the U.S.: Bureau of Economic Analysis.

[13] The methodology follows Maddison (1987, 1993) and O'Mahony (1993). We are grateful to Mary O'Mahony who provided hitherto unpublished data enabling us to compute capital stocks with a consistent definition of the market sector in each country.

[14] We display capital *per capita* because we ultimately want to explain differences in per capita income.

[15] Data for 1994 and 1995 from McKinsey Global Institute (1997).

[16] 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 Opel (GM) plants in Germany.

[17] 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.

[18] We restrict retail to general merchandise, excluding food, car, gas, drugs, and liquor.

[19] Public wireline and cellular operations. Not included are private networks, equipment, cable services, and bulk line leasing.

[20] The industry comprises generation, transmission, and distribution. We excluded IPPs and autogenerators because capital expenditure data was unavailable.

[21] Weighted by the share of capital services in the five industries.

[22] Throughput is a physical measure: sales divided by the consumer goods PPP. Retail output is value added which is close, but not exactly equal to gross margin which includes intermediate services.

[23] German nuclear power plants supplied 27 percent of total generation in 1993, in the U.S. 15 percent, and in Japan 20 percent.

[24] The value added share of seafood is 15 percent in Japan compared to 3 percent both in Germany and in the U.S.

[25] 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, nuclear power plants had a productivity of 80 percent, fossil fuel plants of 94 percent of the average U.S. level.

[26] This follows earlier research, see Baily (1993), Baily and Gersbach (1995) and the corresponding McKinsey Global Institute reports (1992, 1993). See also Porter (1990) for discussion about the link between global competition and productivity.

[27] The methodology for these kinds of assessments follows the causal hierarchy in Exhibit 10. We first relate management actions such as pricing and product design to capacity utilization, capacity creation, and mix effects. We then made an assessment of how much lower (higher) capacity utilization etc. would have been without the corresponding management action, e.g., without flat-rate pricing of local calls. This step of the analysis was based on published industry studies, benchmark studies made available from the McKinsey industry practice, and/or industry interviews (see related exhibits for sources). Finally, we computed the impact of lower (higher) capacity utilization, lower (higher) capacity creation, or a different (product/format/production method) mix on capital productivity.

[28] According to industry interviews in Japan, as much as 50 percent of SKU's (one SKU represents one specific bar code) supplied by food processing companies in 1994 were not supplied in 1995.

[29] The contribution of this third factor on capital productivity was measured as the increase in capital productivity relative to the other countries' mix of formats.

[30] For instance, cylinder borings by one German auto manufacturer were made with almost double the precision of the industry standard. According to managers of this company, this neither led to smoother engine movement nor to prolonged engine life. Since very recently, borings are made with standard precision.

[31] As an extreme case: German telecom cables are required to be able to withstand the full impact of being run over by a tank without losing their ability to function - although they are dug almost 1 meter under the ground.

[32] For instance, some Japanese retail stores are selling exactly the same products with fewer intermediaries or use less interim storage than other retailers.

[33] The ratio between retail and wholesale volume was about 1:1 in the U.S., but 1:3 in Japan (U.S. Census of Retail Trade, U.S. Census of Wholesale Trade; Japan Census of Commerce).

[34] For details, see the companion paper by Börsch-Supan (1997) and the original report McKinsey (1996). The computation is based on the flow of funds data in the OECD National Accounts, augmented by capital gains from Standard and Poor 500 (U.S.); DZ-Index of all publicly listed companies (Germany); Index of all Section 1 companies listed on the Tokyo Exchange (Japan).

[35] 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.

[36] In addition, only relative productivity can be assessed. While the U.S. electric utility industry may have ample room to improve capital productivity, for instance, by strengthening IPPs, the industry performs even worse in Germany and Japan.

[37] This exercise ignores the possibility of increasing returns, a more complicated aggregate production function (however, see Jorgenson, Gollop and Fraumeni (1987) for the accuracy of a constant returns Cobb-Douglas approximation to the aggregate U.S. production function) as well as the influence of market power driving a wedge between the elasticities of capital and labor and their respective output shares (see Hall (1990), section 5.8, for an adjustment).

[38] In the right chart of Exhibit 23, capital productivity is represented by a ray through the origin. Even if the U.S. had the same capital intensity as Germany, the corresponding ray would have a steeper slope than for Germany.