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THE INNOVATION, UNEMPLOYMENT AND COMPETITIVENESS CHALLENGE IN GERMANY

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ABSTRACT

The Innovation, Unemployment and Competitiveness Challenge in Germany*

The purpose of this paper is to link the twin horns of the European economic dilemma – unemployment and a loss in international competitiveness – to a lack of innovative activity. In Germany the *Innovationskrise* (innovation crisis) combines with the *Standortkrise* (location crisis) and the *Arbeitslosenkrise* (unemployment crisis) to form a triad of economic challenges for the 1990s. This paper documents the extent of this economic dilemma confronting Germany as well as the rest of Western Europe and explains how this dilemma developed in the first place. Finally, policies are recommended that can be implemented to overcome this new economic challenge of the 1990s.

JEL Classification: L0, O3
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NON-TECHNICAL SUMMARY

The most visible and pressing economic problem in Germany, as throughout Europe, is unemployment. An unemployment rate of nearly 11% in 1994 for the European Union suggests the urgency of policies leading to the generation of new employment. But unemployment is not the only problem. Two additional problems are a lack of innovative activity and a deterioration of international competitiveness. The purpose of this paper is to show how these three problems are interrelated and to suggest policies that could be pursued to alleviate these problems.

Among the most cited sources of evidence for the existence of a German innovation crisis is the declining share of patent and R&D activity *vis-à-vis* Japan and the United States. But a more careful inspection reveals that the relative technological advantage of German companies in the industries in which Germany has traditionally had comparative advantages, such as chemicals, specialized machine tools, and automobiles, has not greatly deteriorated over the past decade.

The innovation challenge in Germany and the rest of Europe does not seem to exist in the industries in which Europe has traditionally held comparative advantages. Rather, the innovation challenge confronting Europe seems to lie in newly emerging industries such as computers, telecommunications, and biotechnology. It is the inability of European firms to innovate and participate in these new industries that is underlying the real innovation crisis in Europe.

The problem in the more traditional industries may have less to do with an innovation crisis and more to do with what is called a *Standortkrise*, or location crisis. High wages and other costs of production dictate that production be shifted out of high-cost locations and into lower-cost locations. Because production processes in traditional industries tend to become relatively standardized, they can be duplicated at much lower costs in other countries. The continued transfer of production facilities out of Germany into lower-cost countries, through foreign direct investment, along with corporate restructuring, have left large numbers of displaced workers unlikely to be re-employed, even once the economic recovery has taken hold.

In other words, substituting technology and organizational innovations for labour has resulted in substantial productivity gains in traditional German industries. This has had a positive impact on firm efficiency. But, at the same time, it places downward pressure on the number of jobs available in these

traditional industries. How and under what conditions can these displaced workers, as well as new entrants, be absorbed into productive activity *in the same Standort*?

The answer suggested in this paper is through shifting economic activity out of traditional industries and into newly emerging industries. As industries mature, it becomes less costly to duplicate their production processes and apply them in a less costly location. Even so-called high-technology industries can become increasingly based upon information (which can be communicated almost costlessly across geographic space) and less based on tacit knowledge (which dictates proximity for transmission) as they mature. In contrast, newer industries have a higher component of tacit knowledge, and thus are less vulnerable to competition from lower production cost locations.

However, there are a number of barriers to shifting economic activity out of traditional industries and into new industries. These barriers are generally linked to a broad set of institutions ranging from finance to labour market policies. For example, a proclaimed virtue of the German banking system and financial system in general is that by allowing bank ownership of private companies, the companies avoid the types of liquidity constraints more commonly experienced by their counterparts in other countries.

While this may be true, it is also a double-edged sword, because it tends to be the large incumbent companies (which are typically imbedded in the existing traditional industries) that receive a generous flow of cash from the banks. What has been overlooked is the difficulties that outsiders and entrepreneurs with new and different ideas about doing something differently have in procuring funding. At the same time, there have been only negligible venture capital and informal capital markets developed to channel finance into projects involving new and different technologies and industries.

The institutional structure (what some prefer to call the national system of innovation) of Germany seems to have been designed for industrial stability and the application of new technological knowledge only within the existing technological trajectories. And yet, as the comparative advantages of the nation increasingly become based on earlier stages of the industry life cycle, the underlying knowledge conditions associated with tacit knowledge, such as greater uncertainty, asymmetries, and costs of transaction, dictate not stability, but rather mobility.

Germany had already had a comparative advantage in moderate-technology and traditional industries during the last two decades. This meant that diffusing technology along existing technological trajectories was sufficient to preserve the international competitiveness of firms and ensure a rising standard of living for the domestic population. But a shift in the comparative advantages of Germany and other countries in Western Europe away from such traditional industries has left a void. The economic challenge confronting Germany at the turn of the century will be to shift its industry structure away from mature industries and products and towards newly emerging technologies and industries.

1 Introduction

Does Europe have an innovation problem? Even a casual glance at newspaper and magazine headlines along with the pleas from various economic ministries suggests that not only does Europe suffer from an innovation problem, but that this problem has reached a crisis dimension.[1] According to *Newsweek*, "With only a handful of exceptions, in nearly every segment of the so-called information-technology industry, there is a rout underway. European competitors are all but invisible."[2] In Germany, for example, the *Innovations-Krise* (innovation crisis) combines with the *Standort-Krise* (location crisis) and *the Arbeitslosen- Krise* (unemployment crisis) to form a triad of economic challenges for the 1990s.

It is argued in this paper that Europe's, and certainly Germany's innovation crisis of the 1990s is not a problem of innovation in the conventional sense. If one examines most of Germany's leading firms in Germany's leading industries -- Bayer in Chemicals or Volkswagen in automobiles -- they remain, more or less, just as technologically advanced and more or less just as competitive as ever. Rather, at the heart of Germany's innovation crisis is not the problem of implementing new technological knowledge in these industries -- automobiles, chemicals and steel -- in which Germany has traditionally been strong -- but rather in implementing new technological knowledge in industries that barely exist in Germany, but are becoming an increasingly important part of economic activity in the United States and Japan -- industries like biotechnology, software, robotics, and knowledge-based services.

In the second section of this paper factors underlying the cause of the so-called *Innovations-Krise* (innovation crisis) are explored. In the third section reasons triggering the loss in international competitiveness of the location (*Standort*) are examined. How the

[1] See for example the lead story in the business section of *Die Zeit*, "Innovation in Deutschland: Den beehäbigen Großunternehmen geht die Erfindungslust verloren: Zu wenig, zu langsam, zu teuer," 12 August, 1994, pp. 15-16.
[2] "Lost on the Infobahn? Europe Is Losing the Technology Business to U.S. and Japanese Firms," *Newsweek*, 31 October, 1994, pp. 40-45.

innovation crisis and *Standort* problem are linked to increased unemployment is discussed in the fourth section. In the final section policy recommendations are made. In particular, it is suggested that a number of institutions, such as finance and the ease with which new firms can be started and terminated, as well as institutions influencing the mobility of labor, may need to be modified away from promoting a more stable industry structure and towards facilitating a more dynamic organization of industry.

2 The Innovation Crisis

2.1 Is There an Innovation Crisis?

Among the most cited sources of evidence for the existence of an *Innovations-Krise* is the declining share of patent and R&D activity vis-à-vis Japan and the United States exhibited by Europe in general, and Germany in particular. But a more careful inspection reveals that the relative technological advantage of German companies in the industries that Germany has traditionally had a comparative advantage in, such as chemicals, specialized machine tools, and automobiles, has not greatly deteriorated over the last decade.

The continued technological leadership of German firms in these industries is evidenced by their sound and profitable recovery out of the recession and rapid recovery in global export markets.[3] The companies in these industries have not exhibited a loss in either innovative capacity or the capacity to adopt innovations made abroad, at least within their narrowly defined industries.

The problem in these industries may have less to do with an *Innovations-Krise* and more to do with a *Standort-Krise*, as reflected by the continued transfer of production facilities out of Germany into lower-cost countries, along with corporate restructuring, which has left large numbers of displaced workers unlikely to be re-hired, even once the economic recovery has taken hold. That is, substituting technology and organizational innovations for labor has

[3] "European Economies: Gloom to Boom," *The Economist*, 24 December 1994, pp. 35-36.

resulted in substantial productivity gains in these German industries, which has had a positive impact on firm efficiency. But at the same time it places downward pressure on the number of jobs available in these traditional industries. How and under what conditions can these displaced workers, as well as new entrants be absorbed into productive activity?

The innovation challenge in Germany and the rest of Europe does not seem to exist in the industries in which Europe has traditionally held a comparative advantage. Rather, the innovation challenge confronting Europe apparently lies in industries where no country has had the comparative advantage -- new industries. For example, a recent cover story of *Newsweek* is devoted to, "Why Europe is Losing the Technology Race"[4] As the lead article of this issue points out, "The problems at Siemens are far from unique. They are, instead, spread throughout much of Europe's high-tech landscape, and in particular what the Germans like to call "telmatik": the rapidly converging fields of computers, telecommunications and television...With only a handful of exceptions, in nearly every segment of the so-called information-technology industry, there is a rout underway. European competitors are all but invisible."

Similar sentiment can be found in Germany, where *Der Spiegel*, observed recently that, "Global structural change has had an impact on the German economy that only a short time ago would have been unimaginable: Many of the products, such as automobiles, machinery, chemicals and steel are no longer competitive in global markets. *And in the industries of the future, like biotechnology and electronics, the German companies are barely participating.*"[5] And the *Wall Street Journal* recently warned that in Germany, "If you look at the chip industry, it's a disaster. And the computer industry has been for many years. Energy technology

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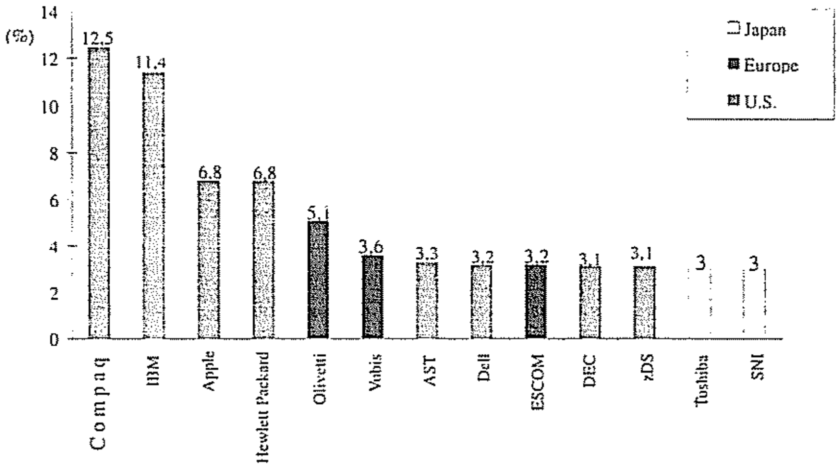
[4] "Why Europe is Losing the Technology Race," *Newsweek*, 31 October 1994.

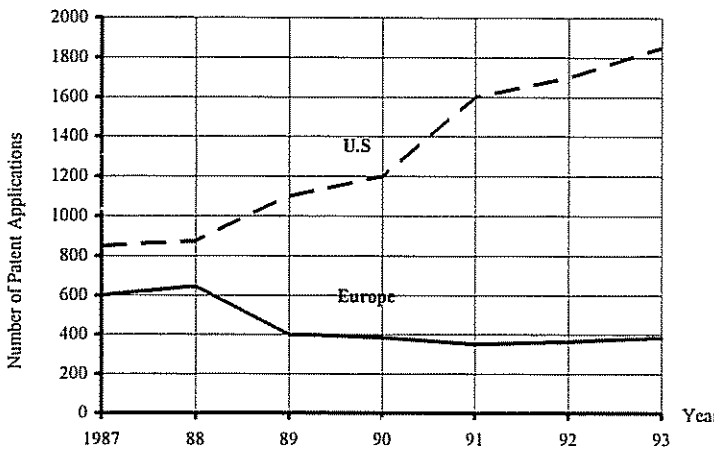
[5] *Der Spiegel*, number 5, 1994, pp. 82-83. The original text states, "Der weltweite Strukturwandel hat die deutsche Wirtschaft mit einer Wucht getroffen, die noch vor kurzem unvorstellbar schien: Viele ihrer Produkte wie Autos und Maschinen, Chemikalien und Stahl sind international nicht mehr wettbewerbsfähig. Und in den Zukunftsindustrien -- der Biotechnik etwa oder der Elektronik -- sind die Deutschen nur unzureichend vertreten."

Figure 1:Market Share of Personal Computers in Western Europe (1994)



as such is a disaster."[6] This echoes the concerns of one of Germany's leading politicians, Lothar Spaeth, and the chairman of the McKinsey & Co. Germany, Herbert A. Henzler, who argue in their best-selling book, *Can the Germans Still Be Saved?*, that Germany's "greatest structural crisis in the postwar period" has been the result of "missing the boat on cutting edge technologies."[7]

Figure 2: Microelectronic Patent Applications in the U.S. and Europe



There is considerable evidence supporting this concern for innovative activity in Europe generally and Germany in particular in high-technology and newly emerging industries. For example, Figure 1 shows that the market for personal computers in Western Europe is dominated by American and Japanese companies. Similarly, Figure 2 makes it clear that patent applications in microelectronics have been growing much faster in the United States than in

[6] "Some Germans Fear They're Falling Behind in High-Tech Fields," *The Wall Street Journal*, 27 April, 1994, p. 1.
[7] Quoted from *The Wall Street Journal*, *Ibid.*, p. 1.

Europe. The same is true for biotechnology (Figure 3) and medical technologies (Figure 4).

Figure 3: Biotechnology Patent Applications in the U.S. and Europe

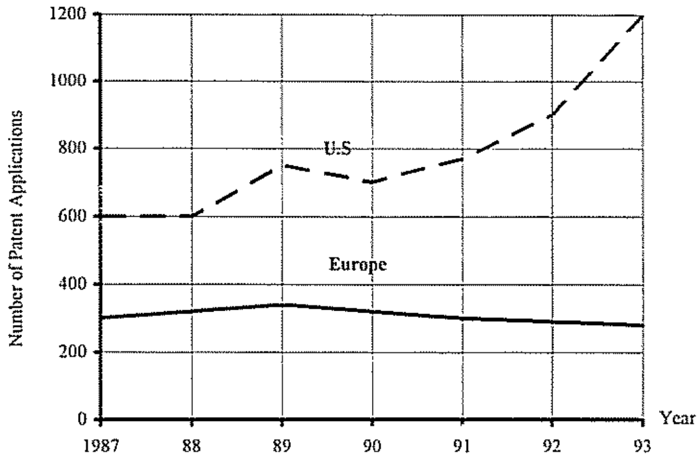
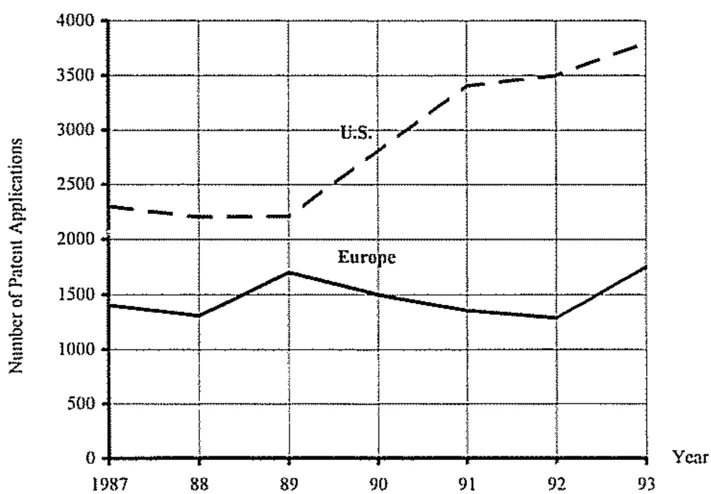


Figure 4: Medical Technology Patent Applications in the U.S. and Europe



2.2 Technological Paradigms and Innovative Activity

2.2.1 Technological Trajectories

Why has it proven to be so difficult to shift economic activity out of traditional industries and into newly emerging industries? At least some insight is provided by the literature identifying the role that specific technological paradigms play in shaping the nature of innovative activity. This literature, which spans organizational theory and business history, suggests that firm behavior and organizations are shaped by the specific technological environment in which firms are operating.[8] In particular, this literature has generally identified that firm behavior is closely linked to core firm competence. That is, firms are organizations with a specific set of competencies engaging in a bounded set of activities. As Nelson and Winter emphasize, firm core competencies typically have a tacit nature and are stored and organized in the routines which guide decision-making.[9] The learning process through which capabilities and routines are developed and shaped is to a large extent local and path dependent.

The concept of *technological paradigms* links the technological environment within which the firm has operated to the core competence of that firm. Innovations that enhance the existing capabilities and routines are generally viewed as falling within the technological paradigm of the core competence of the firm. By contrast, innovations that detract and destroy the existing capabilities and routines of the firm are generally viewed as falling outside of the boundaries of the core competence of the firm.

Whether or not any given firm adopts a new technology will very much depend upon whether that new technology falls within the core competence of the firm or outside of the core technological competence. This is because the cost of adoption to the organization is considerably lower for competence enhancing innovations than for competence destroying

[8] Alfred Chandler, *Scale and Scope* (Cambridge, Mass.: Harvard University Press, 1990).
[9] Richard R. Nelson and Sidney G. Winter, *An Evolutionary Theory of Economic Change* (Cambridge, Mass.: Harvard University Press, 1982).

innovations. Thus, it has been observed that, "Leadership in an old technological paradigm may be an obstacle to a swift diffusion of the new one, especially owing to the interplay between the constraint posed by the capital stock to readjustment of productive activities and the behavioral trends in "old" companies which may embody differential expertise and enjoy high market shares in "old" technologies."[10]

Archibugi and Pianta have analyzed patterns of patenting for specific industries over a broad spectrum of countries and concluded that, even when considered over a long period of time, the technological capabilities of most countries remain remarkably specialized.[11] That is, most countries, especially smaller ones, tend to specialize in technology in just several industries. Within the technological paradigms associated with these industries new technological developments apparently tend to diffuse fairly rapidly. However, there has been little tendency for countries, including Germany and other European countries, to broaden their technological bases, suggesting that diffusion across technological paradigms is considerably more complicated and costly.

2.2.2 Knowledge and Technology Transfer

Cohen and Levinthal argue that firms can influence their ability to adopt new technologies by expanding the boundaries of core competence, or what they term absorptive capacity.[12] While R&D is generally considered to generate new technological knowledge, Cohen and Levinthal argue that it also serves a dual purpose -- to assimilate and exploit existing knowledge, or to facilitate the adoption of existing technology. That is, economists have long observed that firms invest in R&D in order to internalize knowledge which is

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[10] Giovanni Dosi, Keith Pavitt and Luc Soete, *The Economics of Technical Change and International Trade* (New York: New York University Press, 1990, pp. 45-53).
[11] Daniele Archibugi and Mario Pianta, *The Technological Specialization of Advanced Countries* (Boston: Kluwer Academic Publishers, 1992).
[12] Wesley M. Cohen and Daniel A. Levinthal, "Innovation and Learning: The Two Faces of R&D," *Economic Journal*, Volume 99, Number 3, September 1989, pp. 569-596.

external to the firm.[13] Cohen and Levinthal similarly argue that, "While R&D obviously generates innovations, it also develops the firm's ability to identify, assimilate, and exploit knowledge from the environment."[14]

Cohen and Levinthal refer to the two faces of R&D, but there is perhaps also a third face. The nature and direction of R&D activities undertaken, while serving to expand the absorptive capabilities of the firm, may also contribute to defining the boundaries and entrenching those boundaries of the firm's capabilities. Thus, Cohen and Levinthal make explicit reference to the numerous studies identifying that many of the important innovations in new industries come from outside of the emerging industry. For example, most of the computer industry's main innovations originated with developments outside of the industry, particularly in semiconductors.[15] Similar evidence has been found for the aluminum industry.[16] And an important study found that of the twenty-five major discoveries introduced into the United States by DuPont, despite the company's reputation for pathbreaking research, fifteen originated from work done outside of the company.[17] Why weren't these innovations pursued by the firms creating the initial technological knowledge? Presumably because their (restricted) core competencies did not easily permit adopting new technologies beyond the boundaries of the firm's technological paradigm.

It is the boundaries of a firm's core technological competence imposed by the technological paradigm in which the firm has evolved that shape the ability of the firm to adopt new technologies. Numerous anecdotes support the limits confronting a firm's ability to adopt new technologies. For example, Kodak rejected the proposal by Chester Carlsson to produce a

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[13] Kenneth J. Arrow, "Economic Welfare and the Allocation of Resources for Invention," in R.R. Nelson (ed.), *The Rate and Direction of Inventive Activity* (Princeton: Princeton University Press, 1962, pp. 609-626).
[14] Cohen and Levinthal, 1989, p. 569.
[15] Gerald W. Brock, *The U.S. Computer Industry* (Cambridge, Mass.: Harvard University Press, 1975).
[16] M.J. Peck, "Inventions in the Postwar American Aluminum Industry," in Richard R. Nelson (ed.), *The Rate and Direction of Inventive Activity* (Princeton: Princeton University Press, 1962).
[17] Williard F. Mueller, "The Origins of the Basic Inventions Underlying DuPont's Major Product and Process Innovations, 1920-1950 in Richard R. Nelson (ed.), *The Rate and Direction of Inventive Activity* (Princeton: Princeton University Press, 1962, pp. 323-346).

(new) copy machine on the grounds that the new copy machine was not likely to earn very much money. And in any case, Kodak was not in the line of business of making copy machines, but rather photographic equipment. This rejection led Carlsson to start a new firm to produce copy machines, Xerox. [18] It is perhaps no small irony that this same entrepreneurial startup, Xerox, decades later turned down a proposal from Steven Jobs to produce and market a personal computer, because it was not thought that a personal computer would sell, and in any case, Xerox was in a different line of business -- copy machines. After seventeen other companies turned down Jobs for virtually identical reasons, including IBM and Hewlett Packard, Jobs resorted to starting his own company, Apple Computer.[19]

And when Ted Hoff approached IBM and DEC with his new microprocessor in the late 1960s, "IBM and DEC decided there was no market. They could not imagine why anyone would need or want a small computer; if people wanted to use a computer, they could hook into time-sharing systems."[20] It was Hoff's microprocessor, which has been described as a computer on a chip, in that it has a central processing unit (CPU), is programmable, and could readily be connected to memory chips and input-output devices, that was finally adopted by the fledgling start-up Intel, and led to its enormous ascent.[21]

The innovation challenge confronting Europe resembles those confronting IBM. It is often overlooked that IBM has never lost its technological superiority in its core product -- the mainframe computer. Rather, the prolonged crisis at IBM is attributed to the company's inability to extend this technological superiority beyond the technological paradigm of the mainframe computer to the emerging technologies involving new industries in related, but distinct fields. To simply conclude that IBM suffers from an innovation crisis is to overlook the fact that in 1992 IBM registered the most patents of any firm in the world with the United

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[18] This is documented in more detail in David B. Audretsch, *Innovation and Industry Evolution* (Cambridge, Mass.: MIT Press, 1995).
[19] *Ibid.*
[20] *Ibid.*
[21] *Ibid.*

States Patent Office, engaged in greater R&D expenditures than at least any other American corporation, and introduced more new innovative products than any other firm in the United States. If IBM suffers from an innovation problem, it does not lie in a lack of innovative activity, but more likely in the areas, or the industries, associated with that innovative activity. That is, IBM has not suffered from a lack of innovative activity, *per se*, but rather from a lack of innovative activity in newly emerging industries, which Microsoft and Intel have succeeded in doing.

And so it may be with Europe -- the *Innovations-Krise* is not so much a deficiency of innovative activity but rather an inability to shift the technological paradigm away from the more traditional industries and towards new emerging industries.

2.3 Innovation and Location

The importance of geographic proximity for innovative activity in new industries may seem surprising, and perhaps even paradoxical at first glance in a world increasingly relying upon E-mail, fax machines, and electronic communications superhighways. The resolution of such a paradox lies in the distinction between *information* and *knowledge*, especially tacit knowledge. While the cost of transmitting information may be invariant to distance, presumably the cost of transmitting knowledge, and especially tacit knowledge rises with distance. As Glaeser, Kallal, Sheinkman, and Schleifer observe, "After all, intellectual breakthroughs must cross hallways and streets more easily than oceans and continents."[22] That is, location and proximity matter.

The importance of geographic boundaries in what has been termed knowledge spillovers is consistent with the results of a large survey of nearly one thousand executives located in America's sixty largest metropolitan areas, which ranked Raleigh/Durham as the best

[22] Edward L. Glaeser, Hedi D. Kallal, Jose A. Scheinkman and Andrei Shleifer, "Growth of Cities," *Journal of Political Economy*, Volume 100, Number 5, 1992, pp. 1126-1152.

city for knowledge workers and for innovative activity.[23] *Fortune* magazine reports, "A lot of brainy types who make their way to Raleigh/Durham were drawn by three top research universities...U.S. businesses, especially those whose success depends on staying atop new technologies and processes, increasingly want to be where hot new ideas are percolating. A presence in brain-power centers like Raleigh/Durham pays off in new products and new ways of doing business....Dozens of small biotechnology and software operations are starting up each year and growing like *kudzu* in the fertile business climate."[24]

Considerable evidence has been found suggesting that location and proximity clearly matter in exploiting knowledge spillovers.[25] Certainly a wealth of anecdotal evidence supports the contention that the marginal cost of diffusing knowledge across geographic space is non-trivial. For example, in studying the networks in California's Silicon Valley, Saxenian reports that the transmission of economic knowledge is better understood by shifting the unit of observation away from firms to individuals. She emphasizes that it is the direct face-to-face communication between individuals which serves as the key mechanism between diffusing technological (and other economic) knowledge across individuals, firms, and even industries: "It is not simply the concentration of skilled labor, suppliers and information that distinguish the region. A variety of regional institutions -- including Stanford University, several trade associations and local business organizations, and a myriad of specialized consulting, market research, public relations and venture capital firms -- provide technical, financial, and networking services which the region's enterprises often cannot afford individually. These networks defy sectoral barriers: individuals move easily from semiconductor to disk drive

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[23] The survey was carried out in 1993 by the management consulting team of Moran, Stahl & Boyer of New York City.
[24] "The Best Cities for Knowledge Workers," *Fortune* 15 November, 1993, pp 44-57.
[25] For example, Adam B. Jaffe, Manuel Trajtenberg and Rebecca Henderson ("Geographic Location of Knowledge Spillovers as Evidenced by Patent Citations," *Quarterly Journal of Economics*, Volume 63, Number 3, August 1993, pp. 573-598) found that patent citations tend to occur more frequently within the geographic area in which they were patented. However, Maryann P. Feldman ("Knowledge Complementarity and Innovation," *Small Business Economics*, Volume 6, Number 5, October 1994, pp. 363-372) found that the propensity for innovative activity to cluster geographically tends to be greater in industries where new economic knowledge plays a more important role.

firms, and from consulting firms back into startups. And they continue to meet at trade shows, industry conferences, and the scores of seminars, talks, and social activities organized by local business organizations and trade associations. In these forums, relationships are easily formed and maintained, technical and market information is exchanged, business contacts are established, and new enterprises are conceived...This decentralized and fluid environment also promotes the diffusion of intangible technological capabilities and understandings."[26]

The more important tacit knowledge is in generating innovative activity, the more important is geographic proximity and direct interaction. This may explain not only why high-technology firms in Germany and elsewhere in Europe tend to move their headquarters to selected locations in North America, but also why many entrepreneurs elect to start their new firms there in the first place. For example, *Computer Business Review*, a British trade journal, reports that nearly twenty percent of Europe's top 50 software companies had moved their corporate headquarters to America. Sinon and Insignia Solutions, for example, now have American management and headquarters in Silicon Valley, yet both started as British firms, and their founders and many of their staff remain in Britain. Neuron Data is incorporated as Silicon Valley maker of programming tools, but was founded in France.[27]

Similarly, numerous European drug companies are engaging in joint ventures or simply purchasing American biotechnology companies in order to gain access to new technologies. As *Business Week* reports, there has been a wave of strategic alliances in biotechnology between large European drug companies and small American biotechnology startups: "U.S. drugmakers generally have been tentative about biotech investments, mainly taking small equity positions and sponsoring research while trying to build up their internal technological capability.

[26] Anna Lee Saxenian, *Regional Advantage* (Cambridge, Mass.: Harvard University Press, 1990).
[27] "Europe's Software Debacle: Why Doesn't Europe Produce More Good Software Companies?" *The Economist* 12 November, 1994, pp. 71-72.

Europe's drug giants, with few local biotech investors, are hungry for better pieces of the action...The European companies are cherry-picking and doing a good job."[28]

3 The *Standort* Crisis

3.1 The Industry Life Cycle

One of the most important theories in economics shedding considerable light on why countries gain and lose the international competitiveness of an industry is the theory of the industry life cycle. While the theory of the product life cycle dates back at least to Joel Dean in 1950,[29] a more recent and modern description of the industry life cycle has been provided by Oliver Williamson: "Three stages in an industry's development are commonly recognized: an early exploratory stage, an intermediate development stage, and a mature stage. The first or early formative stage involves the supply of a new product of relatively primitive design, manufactured on comparatively unspecialized machinery, and marketed through a variety of exploratory techniques. Volume is typically low. A high degree of uncertainty characterizes business experience at this stage. The second stage is the intermediate development stage in which manufacturing techniques are more refined and market definition is sharpened; output grows rapidly in response to newly recognized applications and unsatisfied demands. A high but somewhat lesser degree of uncertainty characterizes market outcomes at this stage. The third stage is that of a mature industry. Management, manufacturing, and marketing techniques all reach a relatively advanced degree of refinement. Markets may continue to grow, but do so at a more regular and predictable rate. Established connections with customers and suppliers (including capital market access) all operate to buffer changes and thereby to limit large shifts

[28] "Invasion of the Bio-Snatchers: Europeans Are Grabbing Big Stakes in U.S. Outfits," *Business Week*, 28 November 1994, p. 32.
[29] Joel Dean, "Pricing Policies for New Products," *Harvard Business Review*, Volume 28, 1950, pp. 45-53.

in market shares. Significant innovations tend to be fewer and are mainly of an improvement variety."[30]

The most complete version of the product life cycle ascribes four distinct phases that characterize the evolution of a typical industry. Several important technological characteristics have been assumed to vary over the evolution of the life cycle. The most significant assumption is that the product is the most technologically advanced, relative to the stock of knowledge, during the early phases of the life cycle, but through a process of technological atrophy, has been rendered relatively standardized by the time it has evolved into the mature and declining phases. In the introduction and growth stages, it is assumed that no singular product design and concept dominates the industry. Rather, firms must experiment with the design in short production runts, making significant modifications after observing consumer response. Because of the absence of product standardization and reliable product information, the price elasticity of demand is relatively low. Products tend to be distinguished by real technological differentiation, and competition is more technologically oriented than price oriented. Because a rapidly changing product design constrains manufacturing to short production runs, the production process tends to be relatively labor intensive and to require a relatively high degree of skilled labor.

It is also commonly assumed that as the industry evolves towards the mature and declining stages, the product design becomes more standardized and may, in fact, intensify, but this tends to be through image differentiation rather than standardization and uniformity, and the premium attached to technological superiority recedes; product differentiation through technology differentiation. As the product design becomes more uniform, mass-production manufacturing replaces batch runs. Along with the increase in capital intensity there is an

[30] Oliver E. Williamson, *Markets and Hierarchies: Antitrust Analysis and Implications* (New York: The Free Press, 1975).

increase in the minimum efficient scale (MES) -- the minimum level of output, yielding the minimum average cost. And with the reliance upon mass production, unskilled labor can be substituted for skilled labor.

According to the life-cycle hypothesis, the patterns of imports, exports, and foreign direct investment should vary systematically with the evolution of an industry over the life cycle. During the introduction and growth stages, an industry (in a leading developed country) is predicted to be a net exporter and to engage in foreign direct investment abroad. But by the time that the industry has evolved to the declining stage, it is predicted that the industry has become a net importer and engages in relatively little foreign direct investment abroad.

What has occurred between the early and latter life cycle stages to trigger such reversals in flows of exports, imports and foreign direct investment? Diffusion, and in particular, technological diffusion. That is, as the technology becomes standardized and less certain, the cost of diffusing it across national boarders decreases. Just as it is the comparative advantage of the leading developed countries to incur the costs of innovation and establishing new products and processes, it is the comparative advantage of less developed countries to adopt these products and processes once they have become proven viable commodities. The product-cycle theory is more applicable to economic flows, including the diffusion of technology, between the so-called *North and South* countries, than between countries within either stage of development.

What is often overlooked is that the life cycle theory is as much a theory of the evolution of technological knowledge and its diffusion as it was about the life cycle of industries. At the heart of the evolution of technological knowledge over an industry's life cycle was the notion that the returns in innovative activity from a given effort of creating new technological knowledge diminish as the industry evolves. This means that the cost of innovating relative to the cost of imitating also diminish as the industry matures.

In perhaps the most famous version of the industry life cycle model, introduced by Raymond Vernon, it was assumed that

1. the United States was a sole technological leader and a sole economic leader;

2. there are follower developing countries, and

3. industries evolve over a technological life cycle, which is technologically driven by a declining innovative output from a constant input of new technological knowledge.[31]

As an industry matures, technological knowledge also tends to evolve where the content of that knowledge becomes increasingly based on information and less on tacit knowledge. This means that shifting economic activity from established, traditional industries to emerging, newer industries, involves a fundamentally different type of technological knowledge, and in particular, one where diffusing tacit knowledge plays a more important role and diffusing information plays a relatively less important role.

Thus, as the industry matures, the cost of imitating falls relative to the cost of innovating, so that it becomes more economical to transfer that technological knowledge to less costly locations of production -- developing countries -- through foreign direct investment as the industry matures over the life cycle.

3.2 Economic Convergence among Developed Countries

What was not anticipated and where the simple theory of the industry life cycle broke down is that the United States would not remain as the sole technological leader. As Europe and Japan recovered from the War, not only did they achieve technological parity in many industries, but actually became innovative leaders, causing downward pressure on U.S. living standards, just as European real wages and living standards expanded. That is, a process of convergence across the leading industrial countries has taken place during the past forty years.

[31] Raymond Vernon, "International Investment and International Trade in the Product Life Cycle," *Quarterly Journal of Economics*, Volume 80, Number 2, May 1966, pp. 290-207.

Giersch, Paqué and Schmieding point out that the German *Wirtschaftswunder*, or economic growth miracle, was fueled to a considerable extent by relatively low labor unit costs and an undervalued currency.[32] Thus, technology developed in the United States could simply be adopted with the end result of lower unit costs of production and international competitiveness in Europe. But as the European countries caught up to the United States, and the unit cost of labor began to even surpass that of the United States in countries such as Germany, simply following a strategy of technology adoption is no longer sufficient to ensure international competitiveness in Europe. Figure 5 shows that the 1994 mean manufacturing employee compensation (including insurance and other employee benefits) was the highest in Germany, at $25.71 per hour. By contrast, the mean hourly manufacturing wage was just $19.01 in Japan and $16.73 in the United States.

3.3 Economic Divergence from the Developing Countries

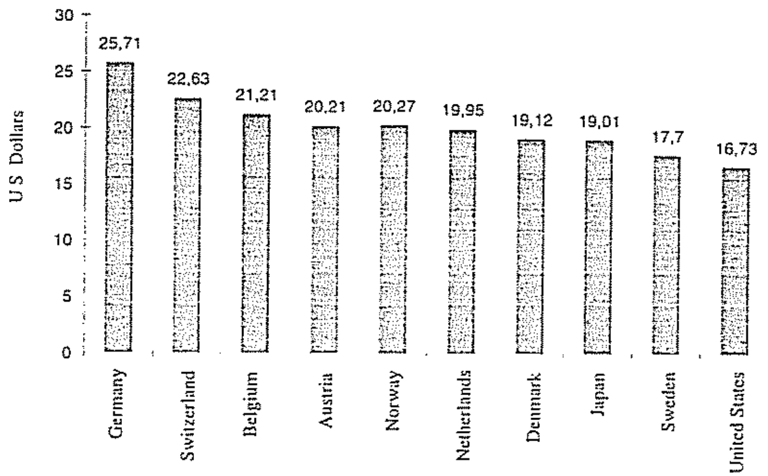
Many of the industries which have been the traditional strengths in Western Europe have evolved towards the mature and declining stages of the life cycle. This means that *Standort* Deutschland becomes increasingly vulnerable, since the production of rather standardized technologies can be shifted to locations in central and Eastern Europe, or in Asia, with lower production costs. As Table 1 shows, the daily earnings of labor (1992) have been estimated to be $78.34 in the European Union, but only $6.14 in Poland, and $6.45 in the Czech Republic, $1.53 in China, $2.46 in India and $1.25 in Sri Lanka.[33]

While labor cost disadvantages can be offset through productivity increases and innovative activity, innovative activity itself tends to become more incremental in nature as the industry evolves over the life cycle. Therefore, in mature industries it becomes increasingly difficult for European industries to maintain their international competitiveness through

[32] Herbert Giersch, Karl-Heinz Paqué, and Holger Schmieding, *The Fading Miracle*, (Cambridge: Cambridge University Press, 1992).
[33] Data are adopted from Michael C. Jensen, "The Modern Industrial Revolution, Exit and the Failure of Internal Control Systems," *Journal of Finance*, Volume 68, Number 3, July 1993, pp. 831-880.

innovative activity. This tendency towards loss of international competitiveness in Western Europe has become the most pronounced in industries such as steel and shipbuilding.

Figure 5 :1994 Hourly Compensation for Production Workers in Manufacturing (in U.S. Dollars)



* Calculation of pay includes insurance and other employee benefits

Table 1: Labor Force and Manufacturing Wage Estimates of Various Countries and Areas Playing an Actual or Potential Role in International Trade in the Past and in the Future

Country/Area	Total Population[a] (Millions)	Potential Labor Force[b] (Millions)	Average Daily Earnings[c] (U.S.$)
Major potential entrants from Asia			
China	1,155.8	464.4	$1.53
India	849.6	341.4	$2.46
Indonesia	187.8	75.4	NA[d]
Pakistan	115.5	46.4	$3.12
Sri Lanka	17.2	6.9	$1.25
Thailand	56.9	23.0	$1.49
Vietnam	68.2	27.4	NA
Total/Average: Total pop./labor force & average earnings	2,451.0	984.9	$1.97[e]
Potential entrant under NAFTA			
Mexico	87.8	35.5	$10.29
Major potential entrants from central and eastern Europe			
Czechoslovakia	15.6	6.3	$6.45
Hungary	10.3	4.2	$9.25
Poland	38.2	15.4	$6.14
Romania	23.2	9.4	$8.98
Yugoslavia	23.8	9.6	NA
former U.S.S.R.	286.7	115.8	$6.69
Total/Average: Mexico, central & eastern Europe	485.6	196.2	$7.49
Previous world market entrants from Asia			
Hong Kong	5.8	2.3	$25.79
Japan	123.9	50.1	$146.97
Korea	43.3	17.5	$45.37
Malaysia	17.9	7.4	NA
Singapore	2.8	1.1	$27.86
Taiwan	20.7	8.4	NA
Total/Average	214.4	86.8	$116.16
U.S. and E.E.C. for comparison			
United States	252.7	117.3	$92.24
European Economic Community	658.4	129.7	$78.34
TotalAverage	911.1	246.7	$84.93

[a] Population statistics from *Monthly Bulletin of Statistics* (United Nations, 1993), 1991 data.

[b] Potential labor force estimated by applying the 40.4 percent labor force participation rate in the European Economic Community to the 1991 population estimates, using the most recent employment estimates (*Statistical Yearbook*, United Nations, 1992) for each member country.

[c] Unless otherwise noted, refers to 1991 earnings from the *Monthly Bulletin of Statistics* (United Nations, 1993) or earnings from *Statistical Yearbook* (United Nations, 1992) adjusted to 1991 levels using the Consumer Price Index. Earnings for Poland were calculated using 1985 earnings and 1985 exchange rate. An approximation for the former U.S.S.R. was made using 1987 data for daily earnings in the U.S.S.R. and the estimated 1991 exchange rate for the former U.S.S.R. from the *Monthly Bulletin of Statistics*.

[d] NA = Not available. In the case of Yugoslavia, inflation and currency changes made estimates unreliable. For Indonesia, Vietnam, Malaysia, and Taiwan data on earnings in manufacturing are unavailable.

[e] Average daily wage weighted according to projected labor force in each grouping.

4 The Unemployment Crisis

4.1 The Standort Problem

By remaining locked in the same technology it becomes increasingly difficult to maintain the international competitiveness of a high-cost *Standort*, even though the company itself may be able to retain competitiveness by shifting production out of the high-cost *Standort* to a lower-cost *Standort*. Consider the case of Sweden. Some 70 percent of Sweden's manufacturing employees work for large companies, most of the multinationals, such as Volvo, which have been constantly shifting production out of the high-cost *Standort*, Sweden, and into lower cost *countries*, through foreign direct investment. Between 1970 and 1993 Sweden lost 500,000 private sector jobs, and unemployment is currently 13 percent of the workforce. And Sweden is not an exceptional case. For example, every third car that is manufactured by a German company is actually produced outside of Germany.[34]

While German companies themselves may be able to retain competitiveness by shifting production out of the high-cost *Standort* to a lower-cost *Standort*, new economic activity must be found to replace the loss of the old activity in order to maintain the high living standards. That is, as virtually the highest cost *Standort* in the world, Germany must be constantly substituting the innovation of new products and processes for standardized ones in order to maintain international competitiveness.

4.2 Growth and Employment: The Horns of the European Dilemma

The *Innovationskrise* and the *Standort* Problem are really just twin horns of the same dilemma. The divergence of real living standards combined with the maturation of Germany's traditional industries dictates that either foreign companies gain competitive advantage by diffusing technological knowledge in mature industries, through cloning those technologies and applying them to cheaper location-specific costs, such as wages, or else German companies

[34] "Globalisierung: Auslandsproduktion deutscher Autohersteller," *Handelsblatt*, 31 January, 1994.

themselves maintain their competitiveness through foreign direct investment and shifting production to foreign locations.

The consequences of this second horn of the dilemma become clear when it is considered what happens to the resources in the *Standort* -- particularly labor -- that become displaced as technological knowledge is better economically applied in lower-cost locations. More explicitly, the consequences are the massive downsizing of companies, which has resulted in the greatest unemployment crisis in Germany since the 1920s.

What is to become of this dislocated labor? There may be some lessons from the experience of the United States. On the one hand, those resources, including certain types of labor, that are not complementary to new technological knowledge have earned an increasingly lower return, due to increased international competition.

On the other hand, what saved America from its own innovation crisis in the 1970s was a subsequent shift in economic activity out of mature industries and into newly emerging industries. Employment growth and even employment levels never recovered in traditional mature industries like steel, automobiles, and rubber -- which had been the pride of America in the 1950s and 1960s. For example, Table 2 shows that a wide range of major American companies substantially reduced jobs just within a period of several months at the end of 1993 -- when the recession had long ended and the economy grew at 5.9 percent. Other large companies not included in Table 2 have experienced even greater downsizing over a longer period of time. IBM, for example, reduced employment by 27,000 in 1994. And 183,000 jobs have been eliminated by IBM since 1986, from a base of 406,000 employees, or 45.81 percent.[35]

[35] "Big Blue's White-Elephant Sale," *Business Week*, 20 February, 1995, p. 26.

Table 2 : Downsizing by Large Companies, September 1993 to January 15, 1994

	Announced Number of Jobs Planned to Cut	Percent of Company Labor Force
Phillip Morris	14,000	8
Woolworth	13,000	9
Martin Marietta	11,000	12
Xerox	10,000	10
US West	9,000	14
NCR (AT&T)	7,500	15
RJR Nabisco	6,000	9
Eli Lilly	4,000	12
Warner Lambert	2,800	16
American Cyanamid	2,500	9
US Air	2,500	9
Computervision	2,000	40
Gillette	2,000	6
Upjohn	1,500	8
Anheuser-Busch	1,200	10
Chemical Waste	1,200	23

Source: The New York Times,Dec. 9, 1993
The New York Times, Jan. 11, 1994

It should also be emphasized that not all corporate downsizing is the result of global competitive pressures. As the Table 2 shows, both firms in financial trouble, such as Martin Marietta, as well as highly successful firms, such as Xerox and Anheuser-Busch, have cut the number of jobs substantially. To some extent these firms, like many if not most firms, have been substituting technology for labor. Experts on the impact of computers on organizations suggest that they have both a direct and indirect effects. Computers directly reduce firm size because information technology often allows fewer employees to do a specified amount of work than before. They indirectly reduce firm size because information technology allows for closer relations with suppliers and customers, thus making it possible for firms to narrow their focus and spin-off previously integrated activities. Thus, while the trend towards downsizing was initially triggered by the need to reduce costs, it also reflects the administrative impact of information and communication technologies. Increased use of technologies, such as electronic mail, voice mail, and shared databases, has, over time, reduced the need for traditional middle management, whose role was to supervise others and to collect, analyze, evaluate, and transmit information up, down, and across the organizational hierarchy.

Unemployment caused by corporate downsizing has extended well beyond the handful of firms shown in Table 2. It has had a massive impact in the United States. Between 1980 and 1993, the 500 largest U.S. manufacturing corporations cut 4.7 million people, or one quarter of their work force. An additional half-million U.S. job cuts followed in 1994, even with the economy well into a four-year recovery.

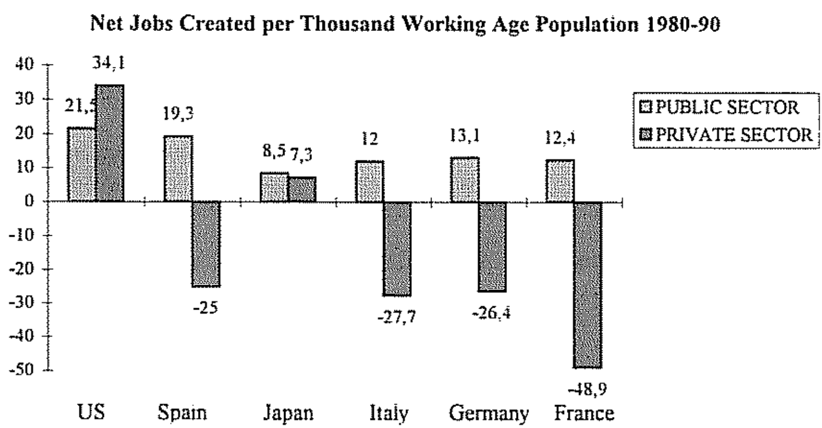
Similar corporate downsizing has taken place in Germany.[36] For example, the German chemical industry is once again profitable and exhibiting strong growth. At the same time, the largest firms in the industry continue to downsize and reduce employment. In 1994 employment fell by 4.7 percent to 531,000. And it is predicted that an additional 30,000 jobs

[36] "Wir Wollen Geld Sehen," *Der Spiegel*, 20 February 1995, pp. 100-102.

will be lost to downsizing.[37] Downsizing has not been isolated in the chemical industry. As *Newsweek* observes, "For the men who run the Siemens Corp., the very heart of Germany's electronics industry, these are the years of blood and anguish."[38] The reason? By the end of 1994 Siemens had 12,600 fewer employees than in 1992.

As Figures 6 and 7 show, despite the massive downsizing in the United States over the past decade, unemployment has continued to decline and employment has grown. Since 1972 the United States created 35 million jobs, mostly in the private sector. By contrast, Europe has created only 11 million jobs since 1972, over half by the state.

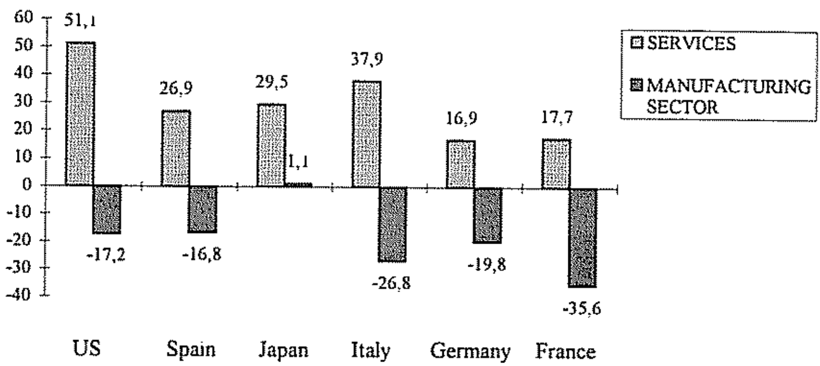
Figure 6: An International Comparison of Job Creation between the Public and Private Sectors



[37] "Chemie: Höhere Gewinne, weniger Arbeitsplätze," *Die Welt*, 21 January, 1995, p. 12.
[38] "Lost on the Infobahn: Europe is Losing the Technology Business to U.S. and Japanese Firms," *Newsweek*, 31 October, 1994, pp. 40-45.

Figure 7: An International Comparison of Job Creation between Manufacturing and Services

Net Jobs Created per Thousand Working Age Population 1980-90



The result of less employment creation in Europe has been the existence of persistently high unemployment rates. As Table 3 shows, the 1994 unemployment rate in the European Union was 10.6 percent, compared to 6.7 percent in the United States and 2.5 percent in Japan. For the OECD countries the unemployment rate was 7.8 percent. Perhaps most striking is the high share of the unemployed in Europe who have been classified as being long-term unemployed -- 42.2 percent.

5 Policy Recommendations

5.1 The U.S. Experience

How has the United States been able to more than offset the impact of corporate downsizing combined with a loss of competitiveness in numerous industries which traditionally had high levels of employment? New employment has been generated through the application of technological knowledge in new industries. It is in the early stages of an industry where the diffusion of technological knowledge is the most costly and the least viable. But because a new technological paradigm is required, more often than not it is new and small firms that are the engine of this economic activity in new industries and in creating the new jobs.

Table 3 : Unemployment Rates

	Unemployment Rates*			Long-Term Unemployed as % of Total Unemployment**
	All Persons	Women	Youths	
United States	6.7 %	6.5 %	13.3 %	11.2 %
Japan	2.5 %	2.6 %	5.1 %	15.4 %
EU	10.6 %	12.2 %	20.6 %	42.2 %
OECD	7.8 %	8.2 %	15.1 %	28.6 %

* From latest standardized unemployment tables.

** Continuous unemployment for at least one year. Source: OECD

The American industrial landscape has been transformed in a relatively short period of time. A number of corporate giants such as IBM, U.S. Steel, RCA, and Wang have lost their aura of invincibility. Only slightly more than a decade ago, Peters and Waterman, in their influential best-selling management book, *In Search of Excellence: Lessons from America's Best Run Companies*, identified IBM as the best-run corporation in America. At the same time has come the breathtaking emergence of new firms that barely existed when Ronald Reagan was first elected President, such as Microsoft, Apple Computer, Intel, Gateway, Dell, and Compaq Computer. In the 1950s and 1960s it took two decades for one-third of the Fortune 500 to be replaced. And in the 1970s it took the entire decade to replace the Fortune 500. By contrast, n the 1980s it took just five years for one-third of the Fortune 500 to be replaced.[39]

Perhaps even more impressive than the handful of new enterprises that grow to penetrate the Fortune 500 are the armies of startups that come into existence each year -- and typically disappear into oblivion within a few years. In the 1990s there are around 1.3 million new companies started each year.[40] That is, the U.S. economy is characterized by a tremendous degree of turbulence. It is an economy in motion, with a massive number of new firms entering each year, but only a subset surviving for any length of time, and an even smaller subset that can ultimately challenge and displace the incumbent large enterprises.

As *Business Week* has observed, "In recent years, the giants of industry have suffered a great comeuppance -- as much from the little guys as from fierce global competition. IBM continues to reel from the assaults of erstwhile upstarts such as Microsoft, Dell Computer, and Compaq Computer. Big Steel was devastated by such minimills as Nucor, Chaperral Steel, and Worthington Industries. One-time mavericks Wal Mart Stores and The Limited taught Sears, Roebuck a big lesson. Southwest Airlines has profitably flown through turbulence that has caused the big airlines to rack up $10 billion in losses over the past three years. And a brash

[39] David B. Audretsch, *Innovation and Industry Evolution* (Cambridge: MIT Press, 1995).
[40] *Ibid.*

pack of startups with such names as Amgen Inc. and Centocor Inc. has put the U.S. ahead in biotechnology -- not Bristol-Myers, Squibb, Merck, or Johnson & Johnson.[41] Thus, as *Newsweek* points out, the emoloyees displaced to corporate downsizing have been re-employed by the creation of new and small firms: "In a surging U.S. economy, while America is adding jobs at the stunning rate of three million a year, giant companies are still shedding workers by the tens of thousands. Old-line manufactures such as Scott Paper, former high fliers like Digital Equipment, stodgy electric companies like General Public Utilities -- no one seems immune...The story is similar all across American big business. Quaker Oats, the Chicago-based cereals company has announced a re-engineering program that will eliminate an unspecified number of jobs. Ciba-Geigy wants to reduce its U.S. work force of 4,600 by one tenth. Aena, one of the largest U.S. insurance groups, is in the midst of cutting 4,000 of its 42,000 jobs after eliminating a similar number over the past two years. That's only a foretaste of huge reductions to come in insurance, where 2.1 million Americans earn their livings."[42]

5.2 The Dynamic Organization of Industry

Germany apparently has not been at a disadvantage in producing basic knowledge. As *The Economist* observes, " Western Europe has no shortage of capital or educated people."[43] However, the fundamental character of tacit knowledge, which involves high uncertainty, knowledge asymmetries, and a high cost of transacting that knowledge, makes it difficult for the holders of that knowledge to appropriate its value. As *The Economist* also points out, "Yet (Europe) is not creating enough entrepreneurial firms."[44]

For example, a software firm that was founded in Bavaria, FAST, needed more capital to fund product development. But after being continually refused from financial institutions and non-financial institutions, the founder Matthias Zahn is not only planning an Initial Public

[41] *Business Week*, Bonus Issue, 1993, p. 12.
[42] "Famine Amid Plenty: Jobs -- Profits Are Back at Big American Firms, But Not Employment," *Newsweek*, 23 May 1994, pp. 40-41.
[43] "Small, But Not Yet Beautiful," *The Economist*, 25 February, 1995, pp. 88-89.
[44] *Ibid.*

Offering on the NASDAQ, but also to move the company's headquarters from Bavaria to Redwood City, California.[45] This is no isolated example. Scores of entrepreneurs in newly emerging industries, ranging from computer software and hardware to biotechnology and visual reality have engaged in a kind of *Auswanderung*, or emigration, in order to appropriate the expected value of their technological knowledge.

Economists speak of static economic welfare loss, but this is a type of dynamic economic welfare loss in the form of forgone technological knowledge and the economic externalities that would otherwise have been accrued. That such technological knowledge in its early stage flows from Germany, as elsewhere on the continent, to selected locations in the United States may reveal differences in institutions. These institutions make it either relatively more easy or more difficult for people to pursue new innovative ideas. It may be that the institutions of Germany, ranging from finance to the labor market and even to education were developed to excel in the transfer and application of technological knowledge in traditional industries but not in emerging industries. These types of institutions are conducive to channeling resources into economic activities where it is more or less known what is to be produced, how it should be produced and who should produce it.

For example, a proclaimed virtue of the German banking system and financial system in general is that by allowing bank ownership of private companies, the companies avoid the types of liquidity constraints more commonly experienced by their counterparts on the other side of the Atlantic. While this may be true, it is also a double-edged sword, because it tends to be the large, incumbent companies -- which are typically tied to existing technological trajectories -- that receive a generous flow of cash from the banks. What has been overlooked is the difficulty outsiders and entrepreneurs, with new and different ideas, encounter in procuring funding. At the same time there have been only negligible venture capital and

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[45] "German Innovation: No Bubbling Brook," *The Economist*, 10 September 1994, pp. 75-76.

informal capital markets developed to channel finance into projects involving new and different technological trajectories. It is not surprising that one of the most repeated phrases on the pages of the business news over the last few months has been what Helmuth Gümbel, who is research director of the Gartner Group in Munich observed[46] "Put Bill Gates in Europe and it just wouldn't have worked out."[47]

Equity investment in small firms in new industries is scarce. Although the stockmarket established a "regulated bourse" for small firms in 1987, only seven small companies floated shares last in 1993 and just four in 1994. Venture capitalists are rare, in part because they cannot sell their stakes on the stockmarket.[48]

Labor market institutions also may tend to impede the development of new firms pursuing different ideas. As *The Economist* observes, "SPEA Software is the sort of company Germany wants to create. Based near Munich, this developer of multimedia equipment boosted its sales by 60 percent last year to about DM 180 million and got Germany's biggest-yet injection of venture capital. SPEA's success will, however, worry one group: Germany's embattled union leaders. SPEA's 130 employees are not unionised, and it does not yet belong to an employer's association. It is thus not part of the centralised system of labour relations to which most of German industry belongs."[49]

Similarly, the tax laws force the chief executive officers of new companies to start paying out dividends from earnings almost as soon as they appear, pre-empting high re-investment policies. And bankruptcy laws in Germany make it clear that to start a new business and to fail is socially unproductive. After two bankruptcies the entrepreneur is legally left only

[46] "Where's the Venture Capital?" *Newsweek*, 31 October, 1994, p. 44.
[47] Similar sentiment was expressed by Joschka Fischer, parliamentary leader of the Green Party in Germany, who laments, "A company like Microsoft would never have a chance in Germany" ("Those German Banks and Their Industrial Treasures," *The Economist*, 21 January, 1995, pp. 77-78.
[48] German Innovation: No Bubbling Brook," *The Economist*, 10 September, 1994, pp. 75-76.
[49] "Out of Service?" *The Economist*, 4 February, 1995, pp. 63-64.

with the option of becoming an employee. He may not legally rely upon his experience from the bankruptcies to start a third enterprise.

The institutional structure -- or what some prefer to call the national system of innovation --of Germany seems to have been designed for industrial stability and the application of new technological knowledge only within the existing technological trajectories. And yet, as the comparative advantage of the nation increasingly becomes based on the earlier stages of the industry life cycle, the underlying knowledge conditions associated with tacit knowledge, such as greater uncertainty, asymmetries, and costs of transaction, dictate not stability, but rather mobility. Individuals and organizations embodying knowledge have to be as little impeded as possible to seek out ways of combining with complementary knowledge inputs in order to appropriate the value of their knowledge. And this means more movement, both of individual economic agents -- that is workers -- and firms. Germany apparently had the comparative advantage in moderate-technology and traditional industries during the last two decades. This meant that diffusing technology along existing technological trajectories was sufficient to preserve the international competitiveness of firms and a rising standard of living for the domestic population. However, a shift in the comparative advantage of Germany and other countries in Western Europe away from such traditional industries has left a void. The economic challenge confronting Germany at the turn of the century will be to shift its industrial structure away from mature industries and products and towards newly emerging technologies and industries.