Viewpoint

New Tools, New Rules:
Playing to Win in the New Economic Game

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At temperatures near absolute zero, and now at much higher temperatures for some ceramic materials, superconductivity occurs. The rules that govern the propagation of electricity suddenly change. Resistance disappears and electrical devices become much more efficient. Devices that previously could not be built, now can be built – but the powerful currents that are unleashed are difficult to control.

New technologies such as those that have revolutionized information and telecommunications and new institutions such as the European Economic Community are coming together to generate an economic form of superconductivity in the 21st century. Suddenly, a different game will be played, with new rules. The potential will arise for building much more productive economies – but only if participants come to the table with the right playing pieces and understand the new rules.

In the 21st century, comparative advantage will become much less a function of natural resource endowments and capital-labor ratios and much more a function of technology and skills. Mother nature and history will play a much smaller role, while human ingenuity will play a much bigger role. To put it bluntly, comparative advantage will be man-made.

Technology and Comparative Advantage

Since man-made comparative advantage rests on technical knowledge, technology – and especially research and development – will become much more important. In popular thought, the management of technology is usually seen as something of relevance to manufacturing but not to the rest of the economy. Here, however, what was historically true has become untrue. In the 21st century there will be high-tech and low-tech products, but everything will be produced, distributed, and marketed with high-tech processes. Gaming an edge in those processes will be important in almost every industry. It will play a key role in determining the success of individuals, firms, and nations.

For example, new information and telecommunication technologies are going to make most service industries into high-tech process industries. Financial firms are already becoming high-tech manufacturing firms that process money and pieces of paper. Banks have computerized their accounting and installed robots (ATM machines) to deal with their customers. Those whose computer telecommunications systems allow them to code, decode, and move information around the world faster than their competitors win – not some of the time, but all of the time. Expert systems already trade over half of the shares of stock traded on the New York Stock Exchange. Artificial intelligence is now being used to design even better trading systems. In 1991, American financial firms spent $7.5 billion on installing what is essentially a higher-tech financial assembly line. In finance, computer systems are not management information systems but production lines. Systems such as electronic funds transfer will be the high-tech electronic highways of tomorrow.

In air transportation, today's key competitive weapon is the computer reservation system. In the aftermath of airline deregulation, the effective use of such systems allowed America's major airlines to run their new competitors out of business – despite the fact that the new airlines had lower operating costs per passenger seat mile. The technology of subsonic aircraft is 40 years old; world-class reservation systems aren't.

In retailing, too, American firms such as The Limited are engaged in high-tech competition. The Limited was the first to use high-definition television across international boundaries to speed up the buying process between Boston and Hong Kong. If The Limited's inventory information, telecommunications, and CAD-CAM manufacturing systems allow it to know what women want to buy and also allow it to put precisely those clothes on the rack within 28 days while its competitors take 6 months, The Limited wins – and its slower competitors lose.

Turning Technology Upside-Down. But man-made comparative advantage does more than just elevate the importance of technology: it turns the importance of various types of technical progress upside-down.

In the 20th century, the winners were those who invented new products. The British in the 19th century and the Americans in the 20th century got rich doing so. But in the 21st century, sustainable competitive advantage will come much less from new product technologies and much more from new process technologies. Technology will get turned on its head.

American firms spend two-thirds of their R&D budgets on new products and one-third on new processes. Japanese firms do exactly the opposite – one-third on new products, two-thirds on new processes. German firms come right down the middle with a 50-50 split. Not surprisingly, firms earn higher rates of return where they concentrate their talent. While the Americans make a higher rate of return on new product technologies, Japanese firms make higher rates of return on new processes. All three proportions cannot be right. Someone is making a mistake.

That someone is the United States. The world has changed, but it hasn't changed.

In the early 1960s, it was conventional wisdom – and also true – that the rate of return on investment in new product R&D was almost always higher than that on new process R&D. A new product gave the inventor a monopoly power to set higher prices and earn higher profits. The inventor had a new product that others did not have. In contrast, a new process still left the inventor in a competitive business making a competitive product. The inventor's competitors knew how to make the product, and they could always lower their prices to match the inventor's prices as long as they were covering marginal costs in their old facilities.

In contrast, to establish a similar monopoly position by inventing new process technologies, it was necessary to drive one's competitors out of business completely. To do this, the new process technologies had to have average costs below the marginal costs of the old process technologies. Since marginal costs are typically far below average costs, an enormous (very unlikely) process breakthrough was necessary. Driving one's competitor out of business was also likely to get one into trouble with the antitrust laws. With new products, in contrast, there were no old competitors to be driven out of business. Since new process technologies were less profitable than new product technologies, it was reasonable for a firm to spend most of its R&D money on new product development.

In the 1950s and 1960s, the United States had such a technical lead that it was virtually impossible for either Japan or Germany to even imagine becoming leaders in the development of new products. They could only hope to compete in existing markets. As a result, they invested less of their GNP in R&D, and what they did invest, they invested more heavily in process R&D. They had no choice.

Today, however, levels of technical sophistication in Germany, Japan, and the United States are not very different. Furthermore, reverse engineering has become a highly developed art form. The nature of the change can be seen in the economic history of three of the leading new products introduced into the mass consumer market in the past two decades – the video camera and recorder, the fax machine, and the CD player. Americans invented both the video camera and recorder and the fax; Europeans (the Dutch) invented the CD player. Measured in terms of sales, employment, and profits, all three have become Japanese products.

If I can make a product cheaper than you can, I can take it away from you even if you are the inventor. In today's world, it does very little good to invent a new product if the inventor is not the cheapest producer of that product. What necessity forced upon Germany and Japan 30 years ago happens to be the right long-run strategy today.

A Commitment to R&D. The importance of man-made comparative advantage and the accelerating technological competition that flows from it will force the United States to alter its R&D spending patterns. In the past 15 years, Japan and Germany have pushed their spending to American levels – slightly less than 3 percent of GNP. In raw numbers, the United States now is the world's fifth-largest spender on R&D as a fraction of GNP. If military spending is left out of the analysis, however, the United States drops to tenth. Civilian R&D accounts for only 1.9 percent of the GNP in the United States, as compared to 2.5 percent in Germany and 2.8 percent in Japan. If government spending is ignored completely, private American firms rank 20th among countries in the fraction of their sales devoted to R&D.

Japan has announced plans for further R&D spending increases in the 1990s. The Europeans, meanwhile, are rapidly developing pan-European, partially government-financed R&D consortiums such as Eureka, Jessi, and Esprit. In America, by contrast, the end of the cold war and cutbacks in military spending will undoubtedly lead to cutbacks in military R&D. Private R&D spending is also falling, at least in the short run, because of the higher debt burdens incurred in the takeover wars – although it is difficult to be sure because of the strong cyclical element in American R&D spending. While others are beefing up R&D spending, America seems to be cutting back.

Traditionally – outside the health care area – the U.S. Government has not directly financed civilian R&D. Except for certain technologies that were justified as defense-related, and thus supported by the Defense Department, technologies with potential civilian applications have not been supported. But to compete in the 21st century's technological race, the United States will have to develop institutions for infusing public money into civilian R&D spending just as its competitors do. It is impossible for any private firm to capture all of the benefits of R&D. Private spending will always be too small.

Furthermore, at the world level there is a „free rider“ problem. Unless the government has an active policy to stop firms from free riding the R&D expenditures of others, the pioneers will never be able to sustain their competitive advantage long enough to build on it.

Another issue that needs addressing is the allocation of R&D. In the new focus on process technologies, who will invest the necessary funds to develop the new products of the future? The answer may be an agreement for the major countries to move toward a German 50-50 split in R&D spending between process and product technologies rather than having everyone move toward the current Japanese 2/3-1/3 split. Alternatively, everyone might agree to cooperate in a World Science Foundation to finance new product technologies.

In any case, in the 21st century man-made comparative advantage will be the starting point for economic competition. Careful strategic planning will be required to seize the growth industries of the 21st century. The technological competition among nations and regions has intensified – and is going to intensify further.

Leadership for Technological Advantage

Just as the new economic game will force the United States to alter its R&D spending patterns, it will also require a much more difficult shift in human resource allocation. Over time, the pay and promotion curves for managers and engineers handling production-process problems have fallen behind those in design and new product development. In the United States, production has ceased to be the route to the top. Among today's CEOs of Fortune 500 companies, 34 percent come from marketing, 25 percent from finance, 24 percent from general management, and only 4 percent from production. Noticing this fact, America's brightest and best talent have not gone into the production area. Reversing this allocation of talent will be very difficult. What has come to be seen as a second-class activity has to be made into a first-class activity. Traditional salary scales and promotion practices have to be disrupted.

If process technologies he at the heart of the competitive equation, it is necessary to have CEOs who understand process technologies. The firm's central competitive weapon cannot remain a black box for which the CEO has to rely on the advice of experts. Large investments in revolutionary technologies will be made quickly only if the man or woman at the top understands them. Yet American CEOs are much less likely to have technical backgrounds than those in either Japan or Europe. There, 70 percent do; here, 30 percent do. This difference in educational background is not unrelated to the fact that, in industry after industry, American firms have been slow to adopt revolutionary new technologies. In industry after industry, Japanese firms are generally faster to bring both products and processes to market than the equivalent American firms. The normal expected educational background of top business leaders has to change. This means that today's business leaders have to choose very different people to succeed themselves – something not often done.

Universities, like companies, face the same need to redirect their talent. Until recently, at MIT, neither engineering nor management students were going into the production/process area. New graduates who went to work in that area did not make the same starting wages, nor did they get promoted as fast, as their classmates who went into research and design. To reverse this pattern, MIT started a Leaders for Manufacturing Program. We launched the program with the help of 11 companies that allow MIT to use their production facilities as laboratories in which students can write theses and conduct process research. Each of these companies is trying to upgrade the prestige of production as a route to the top – a place where one gets treatment that is equal (or maybe better than equal) to treatment in the finance or marketing areas. General Motors' recent promotion to CEO of someone who had been chief engineer after a long sequence of CEOs who had come from finance is perhaps a positive sign of the times.

The Skills to Make Technology Work

While technology creates man-made comparative advantage, seizing that man-made comparative advantage requires a work force skilled from top to bottom. The skills of the labor force are going to be the key competitive weapon in the 21st century. While brainpower will create new product and process technologies, skilled labor will be the arms and legs that master them. Natural resources, capital, and new product technologies are going to move rapidly around the world. Skilled people will remain as the only sustainable competitive advantage.

If the winners are the inventors of products, the education of the top 2 5 percent of the labor force is critical, because someone in that group will invent the new products. If the winners are the cheapest and best producers of products, the education of the bottom 50 percent of the population moves center stage, because this part of the work force must master the new processes. If the bottom 50 percent cannot learn what must be learned, new high-tech processes cannot be employed. If a firm or country is to be successful, each and every worker must have high-tech skills. Firms have to be able to use new computer-based CAD-CAM technologies, employ statistical quality control, manage just-in-time inventories, and operate flexible manufacturing systems. Information technologies have to be integrated into the entire production process, from initial designs through marketing to final sales and supporting services such as maintenance.

The office, the factory, the retail store, and the repair service will need workers with higher average levels of education and skill than in the past. To employ statistical quality control, every production worker must be taught some simple operations research techniques. To learn what must be learned, every worker must have a level of basic mathematics far beyond that achieved by most American high school graduates. Without statistical quality control, today's high-density semiconductor chips can be invented, but they cannot be built.

Put bluntly, those with the best work forces will win the competitive game of the 21st century. The quality of the work force is the key strategic competitive weapon for the individual, the firm, and the nation. In a global economy, those without skills have to face what economists know as „factor price equalization." The unskilled who live in a rich society can make no more than the unskilled who live in a poor society. If the unskilled in rich societies won't work for such wages, unskilled jobs will simply be moved to poor countries where the unskilled will work for such wages. In a global economy, the effective supply of unskilled workers expands enormously and the wages of the unskilled in rich countries fall.

What theory predicts, reality delivers. The impact of factor price equalization can be seen in the wages of American workers over the last two decades. Between 1973 and 1990, America's real per capita GNP rose 28 percent – yet real hourly wages for nonsupervisory workers (about two-thirds of the total work force) fell 12 percent and real weekly wages fell 17 percent. The decline continues at the rate of about 1 percent per year. The lower the education level, the bigger the decline in real earnings. Living in a country with a rising per capita GNP did those Americans without skills no good in the last 20 years.

Competition based upon work-force skills creates a problem for Anglo-Saxon firms, since they often do not see human resource management as central to their competitive survival. In America or Great Britain, skill acquisition is an individual responsibility and firms exist to beat wages down. Adversarial labor-management relations are part of the system. Labor is simply another factor of production to be hired at the lowest possible cost, much as one buys raw materials or equipment. Workers are not members of the team.

Japan and Continental Europe take a different approach. In Japan, the head of human resource management is usually the second most important person after the CEO. In an American firm, the CFO, the chief financial officer, is almost always second in the pecking order. The head of human resource management is usually much lower in the American firm's pecking order and often is a specialized, dead-end job. Commonly, the occupant of this position is not involved in making the firm's key strategic decisions.

While American firms often talk as if they are investing vast amounts in their work forces, they in fact invest less in the skills of their workers than either Japanese or German firms. The investment they do make tends to be highly focused on professional and managerial employees. And the limited investments that are made in average workers are narrowly focused on the specific skills necessary to do the next job, rather than on the basic background skills that make it possible to absorb new technologies.

As a result, problems emerge when new breakthrough technologies arrive. American workers, for example, take much longer to learn to operate new flexible manufacturing stations than those in Germany – thus making the effective costs of buying those flexible manufacturing stations lower in Germany than in the United States. More time is required before equipment is up and running at capacity, and the need for extensive retraining creates bottlenecks that limit the speed with which equipment can be employed. This gap in turn results in less American investment and a slower pace of technical change.

In Germany, there is an extensive training system for the non-college-bound. These young people enter a dual school-industry apprenticeship system at age 15 or 16. At the end of three years, after passing written and practical examinations, they become journeymen with known skill levels. After another three years of work and additional courses in business management, law, and technology, a journeyman can become a master – a credential necessary to open one's own business.

In contrast, America keeps all students on the „college track," even though it knows that only a quarter of them will successfully complete that track. It ignores the fact that skilled blue-collar workers will earn more on average than college-educated workers. The mirage of equal opportunity is used to defeat real opportunity. No one is willing to plan for, or invest in, the skills of the non-college-bound. Relative to the sizes of the two populations, for every $1 per person in taxpayers' money spent on training the non-college-bound, $55 are spent subsidizing those going to college – a system that is neither fair nor efficient.

The skills of the bottom 50 percent of the population affect everyone's wages. If they can't staff the processes that have to be operated, the management and professional jobs that go with those processes also disappear. American economics professors earn three times as much money as British economics professors, not because they know three times as much economics, but because they play on a more productive team.

Head-to-Head Competition

Looking back, the historian in the future will see the 20th century as a century of niche competition and the 21st century as a century of head-to-head competition. The United States, Germany, and Japan all want exactly the same industries to ensure that their citizens have the highest standards of living in the 21st century: microelectronics, biotechnology, the new materials sciences, telecommunications, civilian aviation, robotics plus machine tools, and computers plus software. Each of these seven industries is an example of man-made comparative advantage. Geographically, each of these industries could be anywhere. Where they actually will be located will depend on which country best organizes to ensure that those industries are their industries.

But whereas niche competition is win-win – i.e., most companies have places where they can excel and where they do not face intense competition – head-to-head competition is win-lose. Not everyone will get those seven key industries. Some will win; some will fail.

The shift from niche to head-to-head competition can be seen in the language of current economic discourse, much of which refers to current or anticipated „economic warfare."

On one level, the prediction of economic warfare is good news. Vigorous competition may spur economic growth. There is nothing morally wrong with an aggressive invasion of well-made, superbly marketed German or Japanese products. Being bought is not the same thing as being militarily occupied.

At the same time, the military metaphor is fundamentally incorrect. The economic game that will be played in the 21st century will have a cooperative as well as a competitive element. A cooperative macroeconomic locomotive will have to be built to prevent the cycles that are inherent in capitalism. The world's common environment will require some global cooperation if the world is to be livable for anyone. Some common problems can be solved only in common.

Let me suggest that the military metaphors should be replaced with the language of sports. Despite the desire to win, all sports have a cooperative element as well as a competitive element. One has to agree on the rules of the game, the referees, and what trophies go to the winners. One can want to win, yet remain friends both during and after the game. The economic game of the 21st century will not be economic warfare, but a game that combines the characteristics of World Cup soccer and those of world-class chess.

World Cup soccer is a fluid, aggressive game in which the desire to win is intense. Players must be superb athletes and capable of real teamwork. World-class chess, in turn, requires strategic thinking: the player who is planning his game five moves ahead loses to the player who is thinking six moves ahead. In the words of the world chess champion Kasparov, a competitor „must find the best position for a piece, to fight for the open line, to have a strong center, to attack the opponent's king. Material must be compared against time. Material and time must be evaluated against quality. It takes imagination. At the highest level, chess is a talent to control unrelated things. It is like controlling chaos."

Americans have never been World Cup soccer champions. Only once in recent history has an American been the world chess champion. Basically, Americans are going to have to learn to play a new, faster game. The rest of the world is not going to learn American football. In the economic game about to be played, Americans will have to learn to live with no time-outs, no huddles, and very limited substitutions. And they will need to learn the skills of chess – long-range planning and strategic moves. In the new economic game about to be played, Americans will have to acquire a lot of new skills.

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