Foreign Technology and the United States Economy

Foreign technology could be as helpful to this country as U.S. technology has been in aiding economic growth abroad.

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The decline of productivity growth in the United States and the erosion of U.S. competitiveness in world trade in recent years has caused considerable attention to be focused on developing measures to reverse these disturbing trends. The record shows that productivity growth in the United States decreased from the yearly average of approximately 2.5 percent during 1870 to 1965 to about half of this figure for the years 1965 to 1971. Furthermore, since 1950, productivity growth in this country has slipped below that prevailing in Western Europe and Japan. The concomitant trends in the U.S. balance of trade has been dramatic. Since the late 1950's a deterioration in U.S. trade surplus has occurred, which has been characterized by trade deficits in nontechnology-intensive products being offset by a strong trade surplus in high-technology goods. Since 1970, however, there has been a shrinking surplus in technology-intensive products, to the extent that a negative net trade balance developed in 1971 and 1972 for the first time this century. Despite the fact that the dollar devaluation helped the United States return to a net trade surplus position in 1973, higher oil costs are expected to produce trade deficits again. In addition, exports of formerly high-volume, technology-intensive items, such as nonelectrical machinery and chemicals, continue to show a downward trend in spite of recent devaluations of the dollar (*1*).

Changes in productivity growth rates could significantly affect the ability of the United States to compete in the international marketplace. For example, lower productivity rates contribute to higher product costs and could lead to a loss in trade competitiveness, the extent of the loss depending on additional factors such as monetary exchange rates and unit labor costs relative to those in foreign countries.

Productivity gains can best be achieved by means of technological change, in the view of most economists, because the return on investment in research and development is considered higher than the return from increases in capital or labor. Economic studies have substantiated the importance of technological change in economic growth (*2*). In the United States and in Western Europe, for example, it has been reported recently that the percentage of growth in income per person employed in developed European countries attributable to technological change ranged from 20 to 46 percent in the period from 1950 to 1962 (*3*).

The United States is currently experiencing the consequences of past years of high exports of technology and technology-intensive products. The export of technological know-how, in the form of patents, licensing agreements, manufacturing rights, foreign direct investments, and the sale of high-technology goods, has collectively contributed toward the upgrading of foreign technological capabilities and, coupled with lower foreign labor costs, has resulted in the rapid development of stiff competition for the continued export of U.S. goods to foreign markets. Undisputedly, the export of U.S. technology has aided in large measure the economic resurgence of Western Europe and Japan. A recent study attributes the deterioration of U.S. trade to industrial and technological capabilities growing faster abroad than in the United States (*4*). A corrective measure recommended is for the United States to restrain the export of "naked" technology and to favor the export of technology embodied as manufactured items and finished products. The argument is that the export of technology per se tends to reduce the competitive posture of the United States in the world market. Another explanation is that, in view of the present rapid transfer of technology across national boundaries, the current slowing of the U.S. economy and the higher rate of growth prevailing in Europe and Japan are reasonable manifestations of the considerably higher technological base and maturity of U.S. industries compared with those abroad. It is maintained that in time the growth rates of the other countries will also begin to slow down and reach a common asymptote with that of the United States (*5*).

Perhaps the most common means by which technology is transferred abroad is by the sale of manufactured goods. Manufactured goods, however, generally undergo a definite life cycle so that the contributions of any one product or innovation to the trade balance is transitory. Trade advantages prevail early in the life cycle of the product, but as the particular technology and skills associated with the product are transferred from one country to another, greater competition is developed which erodes the initial advantages until obsolescence or disadvantageous economics take their toll. Because technologies are so rapidly transferred across national boundaries today, and because recipient countries can increase their economic and technological strength as a result of this transfer, a product's competitive life tends to become shorter, dictating the need for each country not merely to maintain but to increase its rate of technological innovation so that it can replace obsolete or less competitive goods and fuel further improvements in its economy and world trade position.

Technological Innovation: The Key to Economic Growth

To improve the rate of technological innovation in the United States, measures are being considered to stimulate greater utilization of available technology and more effective coupling of

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the technology to market mechanisms and incentives rather than to rely on large federal expenditures for industrial R & D. The proportion of industrial R & D funded by the federal government has declined in recent years, from 60 percent in 1959 to 42 percent in 1971 (*6*). This trend reflects the high level of federal expenditures for space and defense in the 1960's. Although more federal funds are currently being directed toward civilian R & D, greater R & D investment by industry is being encouraged to help achieve a higher rate of technological innovation.

Efforts to couple more effectively our technological resources and capabilities to economic growth have resulted in a marked rise in civilian expenditures for R & D in recent years. From 1969 to 1974, these expenditures increased at an average annual rate of 9.1 percent while, in comparison, R & D expenditures for defense increased by 2.4 percent and for space declined 8.0 percent (*7*). Widespread efforts are also being directed toward improving the public-private sector interface (*8*) and improving the general environment for technological innovation. Led by the National Science Foundation, an attempt is being made to determine the principal factors tending to help or hinder the innovation process and to develop policy options and viable industry incentives that will result in a more effective national system for translating R & D results into new and improved goods and services (*9*).

The implication is not that new R & D alone is to be emphasized but that the transfer of existing technology to new applications or users is also important because it can measurably expedite the innovation process to the extent that realization of an innovation can perhaps occur in a shorter period of time (*10*). This potential compression of the innovation time period via technology transfer coupled with the anticipated larger number of innovations realizable under a more conducive political-economic environment thus constitutes a double-barreled approach to increasing the rate of technological innovation in the United States.

Foreign Technology as a Resource

That technology has already become a key consideration in the conduct of foreign affairs is illustrated by some of the major issues confronting the United States–Soviet détente, such as the export of U.S. production technology to the Soviet Union and the Warsaw Pact nations. Because of the increased interest shown by other nations in advanced U.S. technology, the Department of Defense has formed a technology export advisory council to develop guidelines for the export of advanced technological products for civilian use, such as jet engines, sophisticated electronics, and computers. Although the United States has benefited from foreign technology in the past (for example, from the turbojet engine from the United Kingdom), the importance of making a more concerted effort to tap foreign technology has been given insufficient attention. Improved international cooperation in technology would not only help to increase the rate of technological innovation in the United States but could also benefit U.S. foreign relations. Such international cooperation has already been developed to some extent in the military sphere and has led the Department of Defense to institute policies specifically directed toward strengthening international cooperation in technology with U.S. allies (*11*).

That there has been little interest in utilizing foreign technology in the United States can perhaps be attributed to insufficient evidence of the contribution which foreign technology can make to this country's technological competitiveness and economic health. Alternatively, perhaps we are overly engrossed in our attempts to learn how to improve the utilization of our own domestic technology. Nevertheless, we can infer from the faster economic growth of the leading industrialized nations of Europe and Japan, and from the rapid upgrading of these countries' technological prowess relative to the United States today, that foreign technology and international technology transfer constitute a significant resource to the United States.

In the United States, the acquisition of foreign technology, for example, through licensing agreements or the purchase of patents and manufacturing rights, would not help the U.S. trade balance initially, because the payment of royalties and fees would increase the net dollar outflow. This adverse effect would be appreciably offset, however, by the savings in R & D investment which would otherwise be needed to duplicate the technology. In addition, the use of foreign technology would provide the R & D planner with added flexibility in the allocation of scarce resources, enabling him to design domestic R & D programs that would complement foreign technology to the best advantage. These considerations are especially important in an era of scarce R & D dollars such as has been experienced in recent years: total R & D expenditures in the United States in 1974 are expected to be 2.3 percent of the gross national product (GNP), down from 2.4 percent in 1973, and 3.0 percent in 1964 (*12*).

The lower risks and significant time-savings associated with the utilization of already-developed foreign technology are also important considerations for U.S. industrial managers who might otherwise rely on domestic R & D to achieve a comparable level of technical capability. Another consideration is the possibility that further refinements or improvements in the acquired foreign technology might provide the needed competitive edge for the recipient company to expand from domestic markets into the international arena. The resultant increase in export volume could more than compensate for the adverse effect on the U.S. trade balance caused by the acquisition and use of the imported technology.

Unlike the United States, nations such as West Germany and Japan have already had considerable experience in integrating their own technological strengths with imported technology and in coupling these technologies to their national economic systems. The United States, which has focused mainly on space and defense efforts and only recently has had to confront problems associated with coupling more closely the nation's technology to economic needs, could therefore benefit from the experiences of these other nations.

Growth in Foreign Technological Activity

A measure of the increased technological competence of foreign countries is available from the record of U.S. patents issued to foreign inventors. Generally, the expenses associated with filing patents in other countries are of such magnitude that the only inventions filed are those that have a high likelihood of realizing a profitable return for the inventor. Yet, in the United States, the percentage of patents issued to residents of foreign countries has increased each year in the last decade, from 17 percent in 1961 to 29 percent in 1971 (*13*). Most of these

patents were issued to residents of the leading Western industrialized countries: Germany, Japan, United Kingdom, and France. Japan recorded the most rapid (fivefold) increase in numbers of U.S. patents obtained during this period, whereas Germany claims the highest percentage of U.S. patents issued to any single foreign country. Such information is evidence of the conviction of other nations that a significant market exists in the United States for foreign technology.

Despite the general increase in technological activity outside the United States, it is interesting to note that the pattern of U.S. receipts and payments for patents, manufacturing rights, and license fees does not reflect any corresponding increase in the utilization of foreign technology. In fact, the opposite trend is discernible, because receipts from foreign countries for U.S. technology experienced a much faster rise than U.S. payments for foreign technology (*1*). The net balance shows a receipts surplus rising from $200 million in 1961 to nearly $500 million in 1971, with Japan accounting for the largest portion of this increase. These figures indicate that the United States is continuing to fuel technological development in foreign countries with little return flow being evident.

Comparison of the ratio of expenditures for R & D to the national GNP in the United States with the corresponding ratio for some of the leading non-Communist industrial countries shows that, between 1964 and 1971, only the United States and the United Kingdom experienced a decline. In that period in the United States, the ratio of R & D to GNP declined from 3.04 to 2.60, while in West Germany it increased from 1.01 to 1.99, and in Japan it increased from 1.40 to 1.85 (*14*). Although the U.S. ratio is still higher, the trends indicate a continued narrowing of the difference.

The professional manpower picture shows a similar story. For example, in 1967 the United States employed more professional manpower on economically relevant R & D than Canada, Japan, or any other single country in Western Europe (*4*). However, the ratio of expenditures for R & D manpower to the GNP for the respective country shows the United States lagging in most cases. R & D manpower expenditures per dollar worth of GNP were nearly three times greater in Japan, over two times greater in the United Kingdom, and 1.6 times greater in West Germany than in the United States. Furthermore, during 1963 to 1969, the growth of professional R & D manpower in the U.S. industrial sector averaged 3.5 percent annually, which is lower than comparable figures available from most of the Western industrialized countries.

Another indication of the extensiveness and potential importance of foreign technology is provided by companies operating in the United States which have succeeded in competing successfully relying mostly on imported technology. One such company is Akzona, basically a fibers company, which has shown a 100 percent increase in sales in the 5 years up to 1973 (*15*). The company's basic strategy is to rely to a large extent on European technology which, when used in conjunction with U.S. technology, allows the company to compete effectively in the U.S. specialty fibers market. Because this company operates in the United States, it is subject to the same regulatory constraints and labor standards as American firms. Hence, its success can be attributed in large measure to its use of European technology rather than to advantageous tax laws, lower labor costs, or more favorable government policies often associated with foreign business success.

Imported Technology in Japan

An outstanding example of the benefits realized from the importation of foreign technology over the long term is provided by the Japanese experience (*16*). A hundred years ago Japan set as its national goal the modernization of industry and, after World War II, the reconstruction of the national economy. With but a few exceptions, Japan found that in most areas it had to rely on the importation of foreign technology in order to acquire the needed technological know-how within a short period of time. Consequently, the importation of foreign technology became a basic government policy fully integrated with the nation's economic and social goals. Government, industry, and universities cooperated closely in pursuit of these national goals. The transfer of technology from abroad became the core of the nation's technological efforts. Domestic R & D was not sacrificed in the process but rather was directed toward improving, extending, or adapting the imported technology to facilitate the innovation process and smooth its integration into the national economic system.

The Japanese success in consumer electronics is illustrative of the results attainable with foreign technology. The basic building blocks of these products, solid state devices and integrated circuits, were imported from the United States for many years. The aim of the Japanese was not to duplicate the U.S. technology but rather to employ and improve it to the extent that successful innovations would be realized.

A look at the R & D expenditures in Japan shows some interesting comparisons with corresponding figures for the United States. An increasing proportion of Japan's resources is being devoted to R & D in conjunction with that country's policy of importing foreign technology. As pointed out earlier, the ratio of R & D expenditures to the national GNP in Japan increased 32 percent between 1964 and 1971, while in the United States this figure showed a 14 percent drop in the same period. In addition, Japan's technological efforts have been characterized by a heavy emphasis on industrially supported R & D. The percentage of total R & D expenditures funded by industry has been rising in both Japan and the United States; but in 1970, 75 percent of all R & D expenditures were funded by industry in Japan, whereas only 40 percent was industrially funded in the United States. In addition, 75 percent of the government-financed R & D in Japan from 1967 to 1968 was related to the civilian economy, compared with only 15 percent in the United States in the same period. Contrary to what one might expect, a high percentage (23 percent in 1970) of the Japanese R & D was basic research conducted around the imported technology. In comparison, basic research in the United States in 1970 constituted only some 15 percent of the total R & D effort.

These figures are indicative of the difference in national outlook which governed the assignment of R & D priorities in Japan and the United States during the postwar period. Whereas Japan allocated R & D resources to spur economic growth, the focus in the United States was mainly on defense and space. Only since the mid-1960's has the United States begun to shift its R & D priorities more toward helping achieve economic objectives. However, in view of the different political, economic, and social forces shaping each country's national

goals and policies, the lesson is not that the United States should emulate Japan's policies and practices in meeting these objectives but that Japan's economic resurgence in this century has been built on a cornerstone of imported foreign technology, a source of technology which has been relatively neglected in U.S. considerations to date.

Toward a New Perspective

The movement of technology between nations can take many forms. Aside from technical publications, technology is transferred chiefly via outright purchases, licensing agreements, sale of manufactured goods, foreign direct investment in plant and equipment, and by means of joint ventures with foreign concerns: The United States is no novice to these different mechanisms for international technology transfer. However, the U.S. technology flow has been predominately outward as a consequence of the nation's former technological dominance. For example, the record of receipts and payments between the United States and foreign countries for patents, license fees, and manufacturing rights shows that since the early 1960's there has been a sharp increase in U.S. receipts relative to payments, signifying an increasing outflow of U.S. technical know-how to foreign countries.

Yet the dollar value of these transactions are but a small part of the value associated with the sale of manufactured goods and the direct investment in plant and equipment overseas which, along with joint ventures, will become even more important as U.S. concerns continue to expand overseas. Hence, to improve the U.S. trade balance it will be necessary to place increased emphasis on higher product sales abroad through export, manufacturing affiliates overseas, or through partnership with foreign concerns rather than on the sale of U.S. technical know-how represented by patents and license fees, for example. In fact, the purchase of foreign know-how by U.S. industry could help fuel the expanded sale of U.S. goods abroad.

Before foreign technology can be coupled effectively to our economic system, greater recognition of and sensitivity for the market potential of foreign technology must be developed. A broader view must be adopted that takes into consideration the potential long-term benefits that could result from the utilization of foreign technology. For example, although the purchase or licensing of a foreign technology requires royalty payments which adversely affect the balance of payments, acquisition of the technology could nevertheless expedite a particular innovation to the point that foreign exchange earnings would materialize that would more than compensate for the temporary drain from royalty payments. Or, in deciding whether or not to enter into a joint venture with a foreign partner, consideration should not only be given to the potential short-term sales increase realizable from the new venture, but should also be given to the longer-term technical benefits that might be gained from such a partnership. Finally, rather than viewing a particular item of foreign technology in terms of its deficiencies and limitations, a company should view the item from the standpoint of how it could be modified or improved to provide a better product or how it could be adapted to meet an entirely new market.

Prospects for the necessary reappraisal of the potential of foreign technology look good. Active involvement in foreign policy matters and international affairs has been a tradition in the United States and this, coupled with our heavy past emphasis on defense and space priorities, helps us focus on the importance of keeping informed on foreign technological developments and progress. United States participation in scientific exchange programs and in international scientific and technical meetings has always been high. In addition, scientific attachés at selected U.S. embassies abroad have the responsibility of keeping abreast of the science and technology policy issues of their host countries that may relate to U.S. foreign policy and international relations. The need exists, however, to focus more on economically relevant technological developments abroad and utilize any appropriate information on such developments in our efforts to promote technological innovation in this country.

The growth in international trade and the increased interdependence of national economies today is reflected in the number of multinational corporations now in existence. Such corporations could become an important factor in the developing U.S. posture for increased sensitivity to foreign technological developments, though the evidence to date indicates that the multinational corporations have in the past contributed significantly to the export of U.S. technology (*17*).

Not to be forgotten, of course, is the rapid growth in U.S. civilian R & D spending since the mid-1960's, which augurs well for the domestic R & D needed to adapt the increasing amount of foreign technological activity to the U.S. economic system.

Constraining Influences

There are several factors that might account for our reluctance to use foreign technology. One factor is that erosion of the accustomed U.S. technological leadership among Free World countries has been manifested only in recent years, and we have simply not had time to adjust our perspectives and policies to accommodate the changing world technological balance. The increased technological competence of foreign countries and the existence of useful technologies abroad may not yet be fully recognized by those positioned to utilize the technology.

Another contributing factor is the "not-invented-here" attitude which leads people to resist innovations based on outside technology. In many organizations a professional value system prevails which is heavily weighted toward originality and inventiveness rather than the application of technology developed by others. This attitude is deeply ingrained and difficult to reconcile with technology transfer and utilization when it has been encouraged throughout the educational and professional life of an individual.

The situation is compounded further by the high volume of technical information being generated today. It has been estimated that the world body of technical literature increased by a factor of 16 in the 40 years from 1930 to 1970 (*18*). This tends to discourage individuals from making any serious attempts to search the literature for applicable technology developed by others, simply because the time and effort required for such a search is often viewed as being more time-consuming than developing a new solution "optimized" to the particular requirement. This latter approach is further encouraged, of course, by the fact that it can lead to greater professional recognition.

The typical large industrial organization in the United States is not organized in such a way as to foster technological innovation, let alone in-

novations based on foreign technology (*19*). The operational philosophy of most mature companies is based on minimizing risk and increasing profits. The performance of the industrial manager is gauged by the annual return on invested capital achieved by his operating unit, so he can ill afford to invest in risky new ventures which, even if successful, would not start generating returns for many years. This incompatibility between the time required for realization of an innovation (generally 3 to 30 years and sometimes even longer) and the industrial manager's preoccupation for short-term gains consequently serves to discourage technological innovation in the United States (*20*).

In contrast, small companies and the individual inventor tend to be more innovative than big companies. The current growth ethic in the United States thus poses a serious threat to the innovational and venturesome spirit of traditional America. The predominance of large industrial organizations is intensifying, yet studies have shown that the majority of important innovations in this century have come from small companies and the independent inventor (*19*). Furthermore, the number of independent inventors applying for U.S. patents has been declining. It is estimated that in 1950 about 50 percent of U.S. patent applications were submitted by independent inventors. But in 1973, this percentage declined to less than 20 percent (*21*).

Diverse factors such as these ultimately affect the nation's economic health. Existing public policies and industry incentives are inadequate for stimulating a higher rate of technological innovation and must be reformulated so that they are more in harmony with private-sector interests. Although the introduction of policies that would encourage the utilization of foreign technology would further complicate the issues, the rapidly changing world technological balance necessitates our having a more global perspective.

The Outlook

It is clear that the technological competence of other countries will continue to increase and that the United States should view foreign technology as a resource which should be tapped to help stimulate our own technological innovation. The extent to which the United States can adapt to these changing conditions today will determine in large measure the nation's level of technological competitiveness tomorrow.

Loss of a technological monopoly by one country means there is more know-how to be gained from other countries. Thus, in the United States we should make a greater effort to keep abreast of scientific and technological developments abroad and should focus particularly on those developments and innovations that might affect our economic and social systems. There must be developed in this country a desire to learn from the experiences of other countries that have coupled their technological strengths to their respective economies, and an increased willingness to pursue innovations based on foreign as well as domestic technology. After all, a basic principle of the free market is to know one's competition and to attempt to improve one's own capabilities and products over that of the competitors.

The United States needs a national technology delivery system to translate scientific and technological know-how into competitive goods and services. Enlightened public policies must accompany adequate industrial incentives in our attempts to effectively bridge the technological-economic interface. Much attention has been devoted to this subject recently and, in particular, to the role of the federal government as a resource of technology. It is argued that greater utilization of the federal technology base by state and local governments would result in their providing more efficient services, and that greater utilization of this base in the private sector would result in a higher rate of technological innovation. However, the United States cannot disregard the rapidly developing foreign technology base. This consideration requires that the federal government take on a new role as an intermediary and a potential user of foreign technology; in this role the government's objective would be to smooth the process by which potential public and private users could obtain access to foreign technology. This new role should not be neglected in current studies of public policy options for enhancing technological innovation in the United States.

In the same way that the predominantly outward flow of U.S. technology in the past has helped improve the economy and technological competitiveness of recipient countries, the development of a technology link feeding back into the United States could help to upgrade U.S. capabilities and technological competitiveness. This improvement of the U.S. posture could in turn contribute toward an increased movement of technology back overseas, thus further upgrading foreign capabilities and stimulating the return flow of technology to the United States, and so on. In this manner, a more mutually beneficial exchange of technology among the industrialized nations might be developed, and the asymptotic national "limits to growth" might be adjusted progressively higher. But before this can become a reality, the feedback link for the return flow of technology into the United States must be securely forged.

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