Naval War College Review

Volume 21
Number 8 *November*

Article 5

1968

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THE "TECHNOLOGY GAP"

BETWEEN THE UNITED STATES AND WESTERN EUROPE

by

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In recent years there has been much discussion on both sides of the Atlantic about a technological gap between the United States and Western Europe. Many commentators have raised the specter of technological domination by the Americans in the decades ahead as the new postindustrial society takes shape under the impact of a Second Industrial Revolution. Proud Europeans reject this prospect of inferiority in language that is emotional and frequently apocalyptic. Prime Minister Wilson, a staunch friend of this country, uttered these words at the Lord Mayor's banquet in London last November:

> . . . there is no future for Europe, or for Britain, if we allow American business and American industry so to dominate the strategic growth industries of our individual countries that they, and not we, are able to determine the pace and direction of Europe's industrial advance, that we are left in industrial terms as the hewers of wood and drawers of water while they, because of the scale of research, development and production which they can employ, based on the vast size of their single market, come to enjoy a growing monopoly in the production of the technological instruments of industrial advance.[1]

What lies behind these words? Is there a technological gap between the United States and Europe, or are other disparities more important? Whatever the disparities may be, are they cause for alarm? What have been their effects on Europe's trade and economic

growth? What are their implications for the future?

American Business in Europe. The extraordinary popularity of the notion of a technological gap is directly traceable to the imposing presence of American business enterprise in Western Europe. Servan-Schreiber in his new best seller, *The American Challenge*, shocks his European readers by starting off with this assertion: "The third industrial power in the world after the United States and the USSR may well be in 15 years not Europe but *American industry in Europe*. Already today, in the ninth year of the Common Market, the organization of this European market is essentially American."[2] The American challenge, then, is U.S. business in Europe, and the now conventional explanation of this challenge is the technological gap. Before looking into this explanation it is necessary to grasp the dimensions of American business enterprise on the other side of the Atlantic.

Table I shows the growth of U.S. direct investment in Western Europe between 1960 and 1966. *Direct* investment (in contrast to *portfolio* investment) involves the ownership and management of business operations abroad by the investing American parent companies.

TABLE I--DIRECT INVESTMENT BY U.S. FIRMS IN WESTERN EUROPE, 1960 AND 1966
(millions of dollars of book value at year end)

Year	Total	Manufacturing	Petroleum	Mining, Smelting	Other
1960	6,691	3,804	1,763	49	1,075
1966	16,200	8,879	3,977	54	3,290

Note: Book values represent the cumulative amounts invested net of liquidations and losses.

Source: W. Lederer and F. Cutler, "International Investments of the United States in 1966," *Survey of Current Business,* September 1967, Table VI, p. 45.

In 6 years U.S. direct investment in Europe rose some 2½ times--an astounding jump by any previous standards. More than half of this investment was in manufacturing, followed by petroleum investment (mainly in refining and marketing activities). Seventy percent of the American investment in the Common Market countries--Germany, France, Italy, Holland, Belgium, and Luxembourg--was placed since the start of 1960 to make a total investment of $7.6 billion. On the usual assumption that each dollar of book value generates $2 of sales, American manufacturing and petroleum subsidiaries in Europe produced and sold about $25 billion of goods in 1966. Such a figure looms very large in European eyes. In the same year the gross national product of Holland was $21 billion.

American business has moved into Europe on this scale to exploit market opportunities created by rapid economic growth and the transformation of European economies into high-consumption societies. Most of the manufacturing investment has entered the research-intensive, high-growth industries that make up the cutting edge of economic advance. Although U.S. industrial investment is only a little over 2 percent of the total industrial investment in the continental European countries and about three times as high in Great Britain, its share of investment in

the key growth industries is much bigger.

In the Common Market, American companies manufacture about 24 percent of the automobiles, 8 percent of the utility vehicles, 55 to 60 percent of the carbon black, and 15 percent of the synthetic rubber.[3] IBM alone accounts for 70 percent of the computer market in Europe, and another 10 percent is taken by Univac, Honeywell, General Electric, and National Cash Register. After General Electric took over Machines Bull in France and the computer segment of Olivetti in Italy, only one large European computer company was left outside of American control.[4]

The leading U.S. companies in Europe are also the technological leaders in the United States and the most successful exporters of U.S. manufactures. From 1962 on the industries that sold 72 percent of U.S. industrial exports--transportation equipment, machinery, instruments, and chemicals--devoted an average of 6 percent of their sales to R.&D. The traditional industries which exported the remainder spent only 0.5 percent of their sales on R.&D.[5] American companies have the biggest share of world exports in research-intensive products (aircraft, electrical equipment, and chemicals), some 30 percent or about twice the overall share of U.S. industrial exports. Of particular note, the United States produces 80 percent and exports 60 percent of the world's electronic equipment.

In short, three features of U.S. business in Europe strike many Europeans as portents of economic domination by the United States: (1) the dramatic rise of the American business presence in the 1960's; (2) the concentration of this presence in key technological industries that are characterized by high R.&D. activity, new products and rapid growth; and (3) the almost complete domination by the Americans of the shining symbol of the new technology--the computer.

The Myth of Size. What explains the competitive vigor of American companies in Europe? In the early 1960's, when Europeans first began to worry publicly about U.S. business, the most popular explanation was the gigantic size of American companies compared to their European counterparts. It became fashionable to compare the sizes of the 10 biggest American companies against those of the 10 biggest European companies. Statements such as these became commonplace: General Motor's annual sales are greater than the entire Dutch gross national product, and General Electric's sales are more than six times the entire French electronics industry.

A refined analysis of company size, however, offers a more balanced picture. For example, the sales of the 25 largest American firms are only twice those of the 25 largest European firms. In light of the much bigger U.S. market, where most American company sales are made, this fact can only be regarded as surprising. Furthermore, many European companies are huge by an absolute standard. In 1966, nine European firms recorded sales of $2 billion or more.[6] Here are some comparisons of the single biggest American and European companies in specific industries. (See Table II)

Table II reveals that the size disparities are notable only in the automobile and the electrical engineering industries. In pharmaceuticals the sales are equal, and Unilever has a big step on Swift in food processing sales. When size is measured by number of employees, the disparities become much smaller because U.S. firms have higher sales/employee ratios.[7] All of the European companies are large even by U.S. standards.

More fundamentally, there is no direct connection between size and competitive performance. Certainly size is

TABLE II--THE SINGLE LARGEST U.S. AND EUROPEAN COMPANIES BY INDUSTRY IN 1966

Industry	Sales (billions of $)	Employees (thousands)
1. Rubber:		
Goodyear (U.S.)	2.5	108.8
Dunlop (U.K.)	1.0	104.1
2. Automobiles:		
General Motors (U.S.)	20.2	745.4
Volkswagen (Germany)	2.5	124.6
3. Aerospace:		
Boeing (U.S.)	2.4	128.5
Hawker Siddeley (U.K.)	1.1	106.0
4. Office Equipment:		
National Cash Register (U.S.)	0.9	79.0
Olivetti (Italy)	0.5	52.9
5. Electrical Engineering:		
General Electric (U.S.)	7.2	350.0
Philips' (Holland)	2.2	244.0
6. Petroleum:		
Standard Oil, N.J. (U.S.)	12.2	149.0
Royal/Dutch Shell (U.K./Holland)	7.7	174.0
7. Pharmaceuticals:		
Pfizer (U.S.)	0.6	33.0
Hoffman La Roche (Switzerland)	0.6	18.0*
8. Chemicals:		
Dupont (U.S.)	3.2	115.2
ICI (U.K.)	2.5	171.7
9. Food Processing:		
Unilever (U.K./Holland)	5.3	300.0
Swift (U.S.)	3.0	50.8

*Estimate

Sources: "The Fortune Directory," *Fortune,* 15 June 1967 and 15 September 1967.

associated with the capacity to bear risks, to finance investment and R.&D., to develop specialized personnel, and the like. But there are numerous examples of smaller companies beating out giant competitors. In a study of 55 industrial products, an EEC group concluded that in most cases the smaller and less concentrated Community industries showed better export results on world markets than their American competitors.[8] The main arguments in favor of size seem to be related to research and financing. A further point: U.S. subsidiaries in Europe are usually smaller than their big European competitors.

The evidence, then, indicates that mere size can not explain the success of American enterprise in Western Europe. Firms grow because they are competitive--not because they are big. In brief, the size disparity issue has proved to be a myth, and it has joined the graveyard of the other myths (notably the "chronic" dollar shortage of the 1950's) associated with United States--European economic relations. Recognition that the most successful American companies in Europe are research-intensive (symbolized by IBM and the computer) plus the "brain drain" of European scientists and engineers to the United States have now drawn attention to another explanation of American economic dominance--the "technology

gap."

U.S.-European Disparities in R.&D. Capability. The first investigations of the "technology gap," sponsored by the OECD, centered on dollar measures of R.&D. expenditures in the United States and European countries. The overall, global expenditure data show a striking disparity in favor of the United States. (See Table III)

At official exchange rates, the United States spends three times as much on R.&D. as Western Europe as a whole and six times as much as the Common Market. The disparity is somewhat less in terms of qualified scientists and engineers plus technicians: the United States/European ratio is 1.5:1 while the United States/Common Market ratio is 2.6:1.

However, these dollar comparisons at official exchange rates underestimate the European position because R.&D. costs less in Europe. For a truer comparison, one study uses a "research exchange rate." At this rate the United States spends about 2½ times as much on R.&D. as Western Europe.[9]

The global indicators also ignore the *composition* of R.&D. activities. A very high fraction of American R.&D. is devoted to atomic, space, and defense industries as compared to European R.&D. (Table IV) Only 28 percent is allocated to the discovery, invention, and development of products for commercial sale. The amount of spin-off from atomic, space, and defense R.&D. to the civilian economy is a controversial issue. There is no question that this R.&D. has given the United States an enormous technical lead over Europe in space and defense technology. But to what extent has this lead benefited American companies in international markets? Specific examples may be

TABLE III--GLOBAL INDICATORS OF R. & D. EFFORTS IN THE UNITED STATES AND WESTERN EUROPEAN COUNTRIES IN 1963/64

A. Gross National Expenditure on R. & D. (millions of dollars at current exchange rates)

Country	Gross Expenditure	Per Capita	Percent of GNP
United States	21,075	110.5	3.4
France	1,299	27.1	1.6
Germany	1,436	24.6	1.4
Italy	291	115.7	0.6
United Kingdom*	2,160	39.8	2.3

B. Manpower Working on R. & D.

Country	Qualified Scientists, Engineers and Technicians	Per 10,000 of Population **
United States	696,500	35.8
France	85,430	17.9
Germany	105,010	18.0
Italy	30,280	6.0
United Kingdom	159,538	29.4

* 1964/65
**Full-time equivalent.

Source: Organization for Economic Cooperation and Development, *The Overall Level and Structure of R. & D. Efforts in OECD Member Countries* (Paris: 1967), Table II, p. 14.

cited to argue one side or the other. Two observations are relevant: (1) the time-lag before commercial application is probably between 5 to 10 years so that the impact of space research has had little effect so far on the competitive posture of U.S. business in Europe, and (2) much of this R.&D. makes no direct contribution to the civilian economy although its longrnn influence may be great.

It would seem important, therefore, to distinguish between noncommercial and commercial research and development activities. Only when R.&D. generates new commercial products and processes does it add to the competitive strength of American companies in Europe and elsewhere. When we adjust for the exchange rate and composition, we find that the U.S. lead in *commercial* research is about 1½:1 over Western Europe. Although this difference is significant, it offers little support for either American complacency or European despondency.

To conclude, the U.S. research advantage over Western Europe is very high only in noncommercial R.&D. In absolute terms, Europe's R.&D. capability ranks with that of the United States and the Soviet Union.[10]

R.&D. Capability and Technological Innovation. R.&D. expenditures, however refined, are not good indicators of technological innovation for two reasons. First, such expenditures measure only research input and tell us nothing about research output. Second, research outpnt itself has no economic significance unless it is applied to the development, production, and marketing of new products. R.&D. is only one element of a complex innovation process or system.

Technology is *knowledge* that is applicable to the production of goods. Technological *innovation* requires the utilization of such knowledge to change the ways in which goods are produced or to create new goods. In a market economy the acid test of a technological innovation lies in its profitable sale to consumers and industrial users. Innovation depends, therefore, on several linkages that connect the laboratory to the marketplace.

TABLE IV--ALLOCATION OF NATIONAL R. & D. RESOURCES BETWEEN DIFFERENT RESEARCH OBJECTIVES IN THE UNITED STATES AND WESTERN EUROPE
(percentage)

Country	Atomic, space and defanse R.&D.	Commercial R.&D.*	Welfare and Miscellaneous R.&D.**
United States	62	28	10
France	45	41	14
United Kingdom	40	51	9
Italy	21	63	16
Germany	17	62	21

* Includes commercial R.&D., R.&D. for economic infrastructure (construction, transportation, et cetera) end agricultural R.&D.

**Expenditures for health, hygiene, et cetera; expenditures in natural science and engineering in higher education and other private nonprofit sectors, excluding those financed by government in atomic, space, defense and infrastructure R.&D.

Source: Orgenization for Economic Cooperation and Development, *The Overall Level and Structure of R. & D. Efforts in OECD Member Countries* (Paris: 1967), Table II, p. 58.

disparities are the high-growth rates in U.S. exports of research-intensive products and the dynamic pace of U.S. investment in Europe. Innovation disparities, as is true of economic disparities in general, form the basis of international specialization and the opportunity for gainful trade among all participants. Disparities also provide incentives for business enterprise to establish operations abroad.

Both U.S. trade and U.S. investment act to close innovation gaps by diffusing new technology throughout the European economy. Trade provides a channel for diffusion through local imitation; investment carries out the entire innovation process on its own.[13] Through trade, Europeans reap the economic benefits of products incorporating the newest American technology. More to the point, the competition of new U.S. exports may encourage, and even compel, European companies to imitate the new technology. However, this result is not at all certain because successful imitation depends both on a willingness to innovate and the technical capacity to do so. As we have observed, European enterprise is commonly slow to innovate (compared to American and Japanese enterprise), although it definitely has the requisite technical capacity. Thus the effectiveness of U.S. exports in closing technological gaps is limited by innovational barriers in Europe.

American business in Europe overcomes these barriers by itself carrying out the innovation task. Indeed, the U.S. multinational company has become a technological innovator on a global scale. Undoubtedly, American companies in Europe have achieved most of the technology transfer from the United States to Europe in the 1960's. In 1964 the United States received $264 million for patents, licenses, and technological know-how from Great Britain, Germany, France, and Italy while paying only $46 million for technology imports from those countries.[14] Significantly, *71 percent of U.S. technology receipts from Western Europe in 1964 came from transactions between American parent companies and their European subsidiaries.*[15]

In the absence of American enterprise, European industry would have been forced to rely entirely on its own innovation. In that event, the innovation gaps between the United States and Europe in all likelihood would have become much greater than they actually are today. As it is, American companies have considerably stepped up the pace of innovation in Europe. Not only have they diffused new technology through their own commercial activities, but they have intensified competitive pressures on European companies to innovate. In short, the direct and indirect contributions of U.S. business enterprise in first creating and then destroying innovation disparities have done much to give Europe the fruits of advanced technology and to spare it from the economic consequence of technological inferiority.

This statement is supported by a recent OECD investigation which concludes that the differences between United States and European R.&D. capability and the initiation of new products and processes have had "no demonstrable effect on the rate of growth of the Member countries."[16] Actually, only within the past few years has the United States matched the higher growth rates in Europe.[17] The OECD goes on to say: ". . . as a corollary of high rates of economic growth and investment in Japan and Europe, new products and processes (including those originating in the United States) have been effectively diffused throughout most of the economies of the industrially advanced Member countries."[18]

The international economic role of a technological leader, the United States has a comparative advantage in products

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embodying new, sophisticated technology. Generally speaking, American companies are the first to introduce new products both at home and abroad. At the start, therefore, American companies have a definite competitive advantage over foreign competitors who continue to rely on traditional products. This advantage, however, seldom lasts because sooner or later all products go through a life cycle that transforms them from specialties into standard products and commodities. Other companies learn to duplicate a new product, and then competition becomes increasingly a matter of costs.

It is in these later stages that European companies can become very competitive because of lower production costs. Except for Great Britain (where innovational enterprise is weakest), all of the European countries have been able to increase their shares in the world markets for technological products in recent years. The U.S. market itself has been successfully entered by European producers of electrical equipment, machinery, machine tools, and business machines, to say nothing of the massive U.S. imports of steel and automobiles. The OECD attributes Europe's success in exporting research-intensive products in part to the high rate of new product introduction associated with the direct investment of U.S. companies in Europe.[19] Therefore, European fears of not being able to compete because of American technological superiority are unfounded when account is taken of product life cycles, Europe's advantages in production costs, and the actual performance of European companies in exporting technological products.

Conclusions. We can now summarize the main points of our analysis of the "technological gap" between the United States and Western Europe. (1) The American business presence in Europe has grown very rapidly in the 1960's, arousing fears of U.S. economic domination. (2) The competitive vigor of American companies in Europe can *not* be satisfactorily explained by their size relative to European companies. (3) Nor is this competitive vigor traceable to the disparity between U.S. and European R.&D. capability, as measured by inputs of dollars and manpower. European R.&D. capability is very high as is indicated by the many recent discoveries and inventions to its credit. (4) Although Europe's R.&D. capability is high, European enterprise is slow to innovate compared to American enterprise. As a consequence, many "innovation gaps" have opened up between the United States and Europe. (5) These innovation disparities create market opportunities for U.S. exports and for U.S. investment in Europe. Through exports, but especially through the activities of American companies in

BIOGRAPHIC SUMMARY

Professor Franklin R. Root occupied the Chair of Economics at the Naval War College in the academic year 1967-68. He holds a B.S. from Trinity College, an M.B.A. from the Wharton School of Finance and Commerce at the University of Pennsylvania, and a Ph.D. from the University of Pennsylvania.

Professor Root is a specialist in International Economics and International Business. He has been an Instructor in Marketing and Foreign Commerce at the Wharton School of Finance and Commerce; Assistant Professor in Economics at the University of Maryland; Economics Research Officer at the United Nations; and Fulbright Professor, Research Institute for Foreign Trade at the Copenhagen School of Economics and Business Administration. He is presently Associate Professor of International Business at the Wharton School of Finance and Commerce.

Professor Root's publications include *International Trade and Finance--Theory, Policy, Practice* (Senior author), *Strategic Planning for Export Marketing*, and numerous articles in professional and business journals.

Europe, new U.S. technology is rapidly diffused throughout the European economy. This diffusion eliminates innovation gaps and provides all Europeans with the economic benefits of advanced technology. (6) Because diffusion is so rapid, the European economy has been invigorated--not hurt--by the U.S. comparative advantage in developing and marketing new products. (7) Because of its technological leadership American industry has an initial advantage in new product competition, but later on in the product life cycle European industry becomes a potent competitor because of its generally lower costs. The pattern of international specialization and trade that emerges from these relationships offers advantages to all participants.

On economic grounds, therefore, the Europeans should welcome American business in Europe. It should be recognized that the objections to the U.S. business presence are political rather than economic. The specter of U.S. economic domination exists only in the minds of Europeans who do not comprehend the dynamics of international competition. But as long as American companies are viewed as instruments of U.S. foreign policy, we can expect European governments to show concern about their presence. And given the phenomenon of nationalism, we can also expect a general resentment of American companies in Europe simply because they are foreign. In the 1970's the emergence of more European companies operating in the United States should temper some of the political objections. However, the problems faced by international companies who are trying to do business on a transnational scale in a world of nation-states will remain for the indefinite future.

FOOTNOTES

1. "Integrated Technology for Europe?" *EFTA Reporter*, 20 November 1967, p. 1.

2. Jean-Jacques Servan-Schreiber, *Le defi americain* (Paris: Editions Denoel, 1967), p. 17. My translation with original emphasis.

3. "American Investments in Europe Grow and Grow," *European Community*, September 1966, p. 7.

4. This company, International Computers and Tabulators (ICT), is now merging with two other British companies to form International Computers, Ltd. with sales of $1.5 billion. To promote this merger, the British Government is providing a grant of $32 million towards the R.&D. costs of the new company and is buying $8.4 million of its equity. See British Information Services, *British Record*, 25 April 1968.

5. "Economic Union Seen as Essential to Close 'Technology Gap,'" *European Community*, April-May 1967, p. 21.

6. "The Fortune Directory," *Fortune*, 15 September 1967, p. 141.

7. This does not necessarily give U.S. companies a cost advantage because wage rates are much higher in the United States than in Europe. The 50 largest firms in the Common Market have almost the same number of employees as the 50 largest U.S. firms.

8. "Are Bigger European Firms Necessary?" *European Community*, April 1966, p. 7.

9. C. Freeman and A. Young, *The Research and Development Effort in Western Europe, North America and the Soviet Union* (Paris: Organization for Economic Cooperation and Development, 1965), p. 11.

10. Both France and Great Britain produce, in relation to the number of persons in the age groups (20-24 years), about as many persons with doctor's degrees in pure science as in the United States. More surprising, the European effort in technological education *surpasses* the U.S. effort both in relative and absolute terms. Overall, the proportion of current educational effort devoted to science and technology combined is higher in Europe than in the United States. See "The Impact of Science and Technology on Social and Economic Development," *The OECD Observer*, April 1968, p. 19.

11. U.S. Dept. of Commerce, *Technological Innovation: Its Environment and Management* (Washington: U.S. Govt. Print. Off., 1967), p. 9.

12. *The OECD Observer*, p. 23.

13. When technology is imported (either in the form of knowledge or embodied in products) and is then used by local enterprise in production, the process is called *technological imitation*. The Japanese, in particular, have demonstrated that a nation with only limited indigenous R.&D. can become competitive in research-intensive industries if local enterprise quickly imitates imported technology.

14. *The OECD Observer*, p. 26-27. These receipts and payments make up the "technological balance of payments." Europeans frequently cite its adverse nature as proving a heavy technological dependence on the United States.

15. *Ibid.*, p. 27.

16. *Ibid.*, p. 25.

17. With the exception of Great Britain which has suffered from a low growth rate despite the fact that its R.&D. expenditures are the highest in Europe. This is additional evidence that the link between R.&D. capability and economic performance is a tenuous one.

18. *Ibid.*, p. 23.

19. *Ibid.*, p. 25.

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> . . . there must be a clear-cut, long-term relationship established between operational intentions and administrative resources. Successful administrative planning is dependent on anticipation of requirements.
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> *Montgomery of Alamein: Memoirs, 1958*