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Can R&D be the R_X for the Midwest?

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Vital to a region's long-run economic growth is the ability of its manufacturing sector to improve product quality and to introduce more technologically advanced products. For the Midwest, research and development spending has been low compared with spending by firms on the East and West coasts. The authors examine whether this shortfall has been significant in the relationship between Midwest firms' R&D expenditures and their sales.

Midwest manufacturing has enjoyed a significant rebound in recent years. Lower production costs, and particularly lower labor costs, have been an essential ingredient of the restoration of competitiveness by Midwest firms.

Nevertheless, the success of the 1980s is no guarantee that the region will be able to maintain a long-term competitive position. Long-run revival also would appear to require the ability to innovate, either through quality improvements or through the introduction of new, more technologically advanced products.

The reasoning is simple. A region that increases its comparative advantage by cutting wages also reduces its standard of living. Lower wages mean reduced purchasing power of workers and, consequently, lower income for regions, which in turn stifles economic development. On the other hand, a region that can gain a competitive edge through producing superior products can do so without lowering wages and sacrificing its standard of living.

Key to developing superior products is research and development (R&D). The question is whether the Midwest has the R&D facilities and funding to foster technological advances that can be transformed into commercial successes. Is this region at a disadvantage in its R&D resources compared with other regions of the country, primarily the East and West coasts with their famed Route 128 and Silicon Valley complexes?

This *Economic Commentary* explores this issue by assessing three aspects of the Midwest's R&D capabilities. First, we consider differences in the level and source of funding among industrial R&D labs in the Midwest compared with those on the East and West coasts. Second, using a recently completed survey of private R&D labs, we consider the internal operation of labs and the perceived barriers that stand between them and their primary research focus. Third, to examine regional differences in the effectiveness of R&D efforts, we relate a firm's R&D expenditures to its sales.

■ Technology and Economic Growth

Research and development provides the seed for technological innovations and new product development. The Committee for Economic Development views technological change as the primary source of economic growth in the United States.[1] Expenditures on private research and development vary considerably across regions. For example, firms headquartered in the Midwest spent an average of $4,088 per employee on R&D in 1988 (see table 1). Although Midwest firms have increased R&D expenditures by 21 percent between 1987 and 1988, the amount spent per employee still falls below the amounts spent by firms headquartered on the East and West coasts. West Coast firms spent $11,363 per employee in 1988, while East Coast firms spent considerably less, $6,010, but still almost half again as much as Midwest firms.[2]

Some of this regional variation in R&D expenditures results from the geographical distribution of industries. The East and West coasts have large concentrations of electronics and pharmaceutical industries, both of which typically spend a larger-than-average amount per employee on R&D. Midwest firms, on the other hand, concentrate more on

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the manufacture of automotive products, consumer products, food, and general manufacturing. These industries spend only one-third the amount per employee on R&D that the electronics and pharmaceutical industries spend.

Comparing R&D expenditures within various industries does not improve the picture for Midwest firms, however. Firms on the East and West coasts outspent Midwest firms in 14 of the 19 industries considered. Midwest firms excelled in only five industries: automotive, chemicals, food, metals and mining, and telecommunications.

One of the most influential factors affecting the amount of R&D expenditures and the nature of research is the federal government, which is the source of nearly half of the nation's R&D funds. Although a large portion of the funds go to universities and government labs, private-industry R&D labs receive one-third of their overall funding from the federal government. Moreover, federal funds make up 70 percent of private industry's funding of basic research. Consequently, allocation of federal R&D funds is an important factor in how much private industry spends on research and development. In fact, some studies have attributed the success of the coastal economies relative to the Midwest to the concentration of federal dollars allocated to those regions.[3]

The uneven distribution of federal R&D funding among regions is quite significant. Midwest states receive $85 per capita in federal R&D funds, while states along the East and West coasts receive $225 and $376 per capita, respectively. Much of this disparity results from the federal government's emphasis on funding R&D related to national defense. In fact, the Department of Defense allocates two-thirds of the federal R&D funds, and three of the top four industries with the highest R&D expenses per employee are defense-related: computers, electronics, and telecommunications. Only the health-care sector, primarily the drug industry, spends more on R&D than these three industries.

TABLE 1 R&D EXPENDITURES PER EMPLOYEE FOR VARIOUS INDUSTRIES, BY REGION

Industry	Midwest	East	West	All
Aerospace	$ 3,546	$ 2,372	$ 4,364	$ 3,349
Automotive	2,869	1,889	814	2,651
Chemicals	6,501	5,515	4,155	5,761
Computers	8,033	11,350	13,270	11,713
Conglomerates	2,075	2,885	2,824	2,627
Construction	3,504	3,512	1,100	3,357
Consumer goods	2,159	2,435	4,184	2,432
Container	1,124	—	—	1,124
Electronics	3,721	5,518	10,800	7,095
Food	3,095	785	510	2,181
Fuel	2,685	4,760	3,931	3,654
General	2,874	2,374	9,424	3,269
Health care	7,943	11,380	18,411	12,606
Leisure	2,285	6,398	5,661	4,495
Metals and mining	2,177	1,986	551	1,836
Nonbank financial	5,000	5,437	3,948	5,116
Paper	1,287	2,252	1,223	1,691
Service	979	1,674	1,150	1,448
Telecommunications	10,023	8,244	9,297	8,598
All	4,087	6,010	11,362	6,820

NOTE: Regions are defined as 1) Midwest (Illinois, Indiana, Iowa, Michigan, Minnesota, Ohio, and Wisconsin), 2) East (Massachusetts, Connecticut, Rhode Island, New York, New Jersey, and Pennsylvania), and 3) West (California, Oregon, Washington, and Utah). Firms are placed in one of these regions according to the location of their headquarters.

SOURCE: Standard & Poor's COMPUSTAT Services, Inc., as reported in *Business Week*, July 1989, and authors' calculations.

The low level of federal R&D funding in the Midwest is partly a result of the small percentage of defense-related firms headquartered in the region. While Midwest aerospace and telecommunication firms spend at or above the national average on R&D, they account for only a small portion of the Midwest's industrial base. Consequently, even if these industries received the same number of federal R&D dollars per employee as similar firms on the East and West coasts, federal R&D funding per capita in the region would still be below the national average.

The federal government also plays a major role in determining the type of research that industrial labs undertake. Responses by R&D lab directors to a recent survey, funded by the National Science Foundation, revealed that government financing strongly influences the focus of their labs' research.[4] Not surprisingly, the federal government's presence was felt more by West Coast labs than by Midwest labs, presumably because of their greater dependence on federal funding. On the West Coast, 63 percent of industrial labs receive some federal funding, compared with 34 percent of industrial labs in the Midwest, according to the survey.

■ Barriers to R&D Productivity

While expenditures per employee is a useful measure of R&D efforts, it may not necessarily reflect the effectiveness with which these dollars are used. The purpose of devoting resources to R&D activities is to develop new techniques and products, which subsequently leads to an increase in company sales and profits. The previously mentioned survey asked several questions of lab directors about their perception of barriers to the lab's productivity. Few differences emerged among R&D labs across the various regions, with a few notable exceptions.

TABLE 2 SALES AND R&D EXPENDITURES BY REGION

Variable	Midwest	East	West
Sample averages:			
R&D expenditures per employee (1984-88 average)	$3,768	$4,719	$10,961
Sales per employee (1988)	$129,902	$136,239	$148,742
Percentage effect of 10% increase in R&D expenditures per employee on (evaluated at sample means for each region):			
Sales per employee	.50	.50	.85

NOTE: The estimates are obtained by regressing the logs of sales per employee on R&D expenditures per employee, industry dummy variables, firm employment, and the dependent variable lagged one year.
SOURCE: *Business Week*, July 1989, and authors' calculations.

Two types of barriers were identified more often by labs in the Midwest than by labs in the two coastal regions. The first barrier was related to the lab's knowledge base as revealed by the question: "Does staying current with rapidly growing scientific and technical knowledge act as a barrier at all to R&D productivity?" A greater percentage of Midwest lab directors responded affirmatively to this question than did their counterparts on the two coasts. Perhaps industrial R&D labs in the Midwest feel more removed from the mainstream networking system. Certainly, the two coasts have the advantage of a high concentration of technical labs and manufacturing facilities, such as the Silicon Valley and Route 128, and the major universities in close proximity to these complexes.

The second potential barrier was related to commercial applications of the lab's research: "Is concern with short-run commercial benefits of R&D a barrier at all to R&D productivity?" Again, a greater percentage of Midwest lab directors responded affirmatively to this question. Identifying commercial pressure as a barrier may reflect the Midwest's lack of federal funding, which leads to increased reliance on corporate funding.

The survey also revealed that Midwest R&D lab directors, unlike their East and West coast counterparts, had little problem with finding adequate personnel. Usually the coasts are thought to have more, sometimes better-qualified, or the "right kind" of professionals and technical personnel. Interestingly, a smaller percentage of labs in the Midwest than on either coast reported that a shortage of adequately trained scientific and technical personnel was a barrier to productivity. One reason for this response may be that professional and technical personnel make up a lower percentage of total personnel in Midwest labs than in East and West Coast labs. Consequently, the need for highly trained scientists may not be as great in the Midwest. Nevertheless, the Midwest is still on par with the rest of the country in terms of the concentration of scientists and engineers employed at doctorate-granting universities and colleges, relative to the population.[5] In comparison, the concentration of scientists and engineers employed at West Coast universities and colleges was only 85 percent of the national average, which may explain the personnel problems there.

■ The Relationship Between R&D Expenditures and Sales

How does the Midwest's shortfall in R&D expenditures affect the ability of its firms to transform R&D efforts into new products and, subsequently, into increased sales and profits? The process from R&D to innovation to new products is very complex, but if one could show a strong relationship between company R&D expenditures and company sales, it would suggest that R&D efforts do lead to successful products. We estimated this relationship for firms headquartered in each of the three regions, controlling for the employment level of each firm and the industry mix of each region.

We find a very strong positive relationship between the average level of R&D expenditures per employee between 1984 and 1988 and the level of sales per employee in 1988. For all three regions combined, a 10 percent increase in R&D expenditures per employee raises sales per employee by 0.67 percent.

The effect of R&D on sales was very similar for Midwest and East Coast firms (see table 2). West Coast firms, on the other hand, exhibited a significantly higher propensity to transform R&D into sales than firms in either the East or the Midwest. One explanation of this difference is the higher demand for R&D expenditures by West Coast firms, brought about in part by greater federal funding.

The difference in results between Midwest and West Coast firms points out a major problem for the Midwest—encouraging firms to devote more of their revenues to R&D efforts. Firms headquartered in the Midwest devote only 2.9 percent of their sales to R&D, compared with 7.3 percent for firms on the West Coast. If Midwest firms would match their West Coast counterparts, R&D expenditures between 1984 and 1988 would have averaged $9,482 per employee—150 percent above the actual amount. According to our simple estimates, this increase in R&D dollars would boost sales per employee in the Midwest by about 7.5 percent above their actual 1988 levels. Of course, the process is not that simple, and the estimates are offered only to dramatize the effects of the low level of R&D spending by Midwest firms.

■ Conclusion

Can increased research and development expenditures boost economic growth in the Midwest? The low level of R&D spending by firms headquartered in this region compared with those on the West Coast is dramatic. Much of

this difference appears to be explained by the heavy concentration of government funding in coastal regions. Certainly, increased R&D expenditures could generate additional sales.

As economies become more globalized and information increasingly more accessible, however, less emphasis may be placed on where basic research is generated and more attention paid to how quickly and effectively one can assimilate it and put it to commercial use. While the U.S. still leads the world in the quality and absolute quantity of R&D, other countries, notably Japan, have taken the lead in developing commercially competitive products.[6] One of the troubling findings in this study is the perception by many Midwest R&D lab directors that they have difficulty staying current with scientific and technical knowledge.

If R&D is to lead to new products and innovative manufacturing processes, several steps are recommended.[7] Managers and stockholders must be willing to take a long-run view with regard to return on assets: in particular, R&D should be treated as an investment rather than an expense. Management should integrate corporate R&D with commercial production in order to shorten the period from the drawing board to the production line. Workers must be willing to adapt to new technologies and workplace arrangements.

Without these fundamental changes, the R&D efforts of labs in all regions of the country will not be able to generate the new products and processes that will allow us to maintain a competitive edge in the world economy.

Footnotes

1. Committee for Economic Development, Research and Policy Committee, *Stimulating Technological Progress*, New York, January 1980.

2. These figures are obtained from Standard & Poor's COMPUSTAT Services, Inc., as compiled by *Business Week*, 1989. The companies included in the survey are limited to those reporting sales of $35 million or more and R&D expenses of at least $1 million or at least 1 percent of sales. Research expenses are those dollars spent on company-sponsored R&D.

3. See Ann Markusen, *High Tech America*, Winchester, MA: Allen & Unwin, 1986.

4. The survey was part of the National Comparative R&D Laboratory Project, which was funded by a grant from the National Science Foundation to Barry Bozeman, Director, Technology and Information Policy Program, The Maxwell School, Syracuse University.

5. Alenka Giese and William Testa, "Measuring Regional High Tech Activity with Occupational Data," Working Paper Series on Regional Economic Issues, Federal Reserve Bank of Chicago, WP-87-1, January 1987.

6. Robert B. Reich outlines several steps to speed the commercialization of new technologies in "The Quiet Path to Technological Preeminence," *Scientific American*, vol. 261, no. 4, October 1989, 41-47.

7. These suggestions have been offered in one form or another by Reich, ibid.; Michael L. Dertouzos, Richard K. Lester, and Robert M. Solow, *Made in America: Regaining the Productive Edge*, Cambridge, MA: MIT Press, 1989; and Martin Neil Baily and Alok K. Chakrabarti, "Innovation and U.S. Competitiveness," *The Brookings Review*, Fall 1985, 14-21.

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