Science: How Much Is Enough?

The military defense of the U.S. has been the best articulated motivation for the support of basic science. Also important has been a widespread belief that scientific leadership would translate into both economic power and a higher standard of living. The disappearance of the threat from the Soviet Union has undermined one of these rationales. The slow growth of the American economy, contrasted with the rapid progress of Japan, which is not a world leader in academic science, has eroded the other.

Does basic research have something to offer when economic progress and improving the environment have displaced the military threat on the nation's agenda? If so, how much basic research is needed?

The history of the computer answers the first question. The transistor could not have been invented without years of basic research that built a quantum mechanical understanding of crystalline solids. Without that work neither the device itself nor the subsequent gains in computing power accompanied by declining cost per circuit element would have been possible. We would not have the computer industry as we know it.

The research in solid-state physics that preceded the invention of the transistor exemplifies one kind of relation between science and economic progress. In this case, it is the emergence of useful technology from research pursued without a visible industrial goal. At the next stage are areas of science such as high-temperature superconductivity that have not generated new industries but do have discernible economic potential. Then there are new science-based industries closely dependent on fundamental research that already yield products. Biotechnology is one. It is not a large industry today, but it has enormous potential. This kind of infant industry, moving at a fast technical and competitive pace, requires continuous input of new science to maintain its expansion.

At the more developed stage reached by the semiconductor and pharmaceutical industries, technical directions have stabilized. In such industries, corporate R&D laboratories meet much of the scientific needs. Then there are industries in which technological change itself is slow. For these the tie to current science is correspondingly weak. Automobile manufacturing is an example of an industry that requires only the science that is available to everyone.

For industries of either of these last two types, ones that are like semiconductors or like automobiles, productivity gains and market dominance come, for the most part, from improving design and production processes, perceptive marketing strategies and managing people to benefit from their most creative capabilities. In some of these industries, we observe that Japan, in spite of its lack of prominence in academic science, has become a global power.

For fledgling science-based industries, then, the linkage to research must be close and continuous. Industries that are already well on their way can be sustained by the work of their own laboratories. For mature industries, the main contribution of science may be the graduates who can use the knowledge available to all.

Clearly, science does have an economic role. How do we decide what science to support and at what level to support it?

Our proposition is a simple one: all major fields of U.S science should be funded at a level that will keep them among the world's leaders. Being one of the leaders will enable us to be among the first to participate in the birth of new industries. This basic economic rationale must apply to all disciplines, because we do not know where the next significant event will take place. Moving quickly when something exciting does happen in a field may even call for increasing the support of that scientific area. Action may be necessary downstream as well.

We are suggesting that the economic criterion for deciding how much to support American science is a comparative one. Can comparisons by disciplines actually be carried out? The many studies conducted by the National Research Council, the opinions of researchers in the field and the number of first-rate scientists in a particular area all provide useful indicators.

We believe the goal of having a world-class scientific enterprise can be obtained without increasing the federal budget. The reason is that in the U.S. most fields of science probably already satisfy our test.

For those sciences that directly support the infant industries we have described, we propose that the U.S. should maintain a definite advantage. We might expect, for example, to see strong support for those parts of molecular and cellular biology and immunology that assure a primary position in therapeutic and diagnostic technology and in agricultural biotechnology. We would expect to see such support for condensed-matter physics, for chemistry and for the material sciences that contribute to the development of products based on high-temperature superconductivity.

None of these considerations should exclude funding based on other objectives and values. They might include contributions to health, to the environment or to other societal goals or a decision to emphasize a field because of its intellectual excitement. The economic rationale based on the comparative world-class criterion, however, should put a firm floor under the support of basic science.

In some cases, for example, space science, we may be spending billions more than anyone else. Funds from such fields should be redirected to areas in which our advantage is less overwhelming. In areas of inquiry—particle physics, for one—that depend on a small number of expensive, experimental installations, our standing could probably be maintained more easily by dealing with the complexities of international cooperation than by absorbing the enormous expense of an unneeded rivalry for world leadership.

We believe this approach would lead to a more predictable, stable scientific environment in which the funding could be determined on a long-term basis. It would help science to be a more attractive career for both the established and the young scientist. It would assure that our leading scientists would be well funded and that our country would be in a position to benefit economically from their work.

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