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It doesn’t matter where scientific discoveries and breakthrough technologies originate—for national prosperity, the important thing is who commercializes them. The United States is not behind in that race.

Now, perhaps, more than ever, the fear of globalization haunts the United States. Many manufacturing companies that once flourished there fell to overseas competition or relocated much of their work abroad. Then services embarked on the same journey. Just as the manufacturing exodus started with low-wage, unskilled labor, the offshoring of services at first involved data entry, routine software programming and testing, and the operation of phone banks. But today, overseas workers analyze financial statements, test trading strategies, and design computer chips and software architectures for US companies.

It is the offshoring of research and development—of innovation and the future—that arouses the keenest anxiety. The economist Richard Freeman spoke for many Americans when he warned that the United States could become significantly less competitive “as large developing countries like China and India harness their growing scientific and engineering expertise to their enormous, low-wage labor forces.” [1] What is the appropriate response? One, from the conservative pundit Pat Buchanan, the TV broadcaster Lou Dobbs, and their like, calls for protectionism. Another, seemingly more progressive, approach would be to spend more money to promote cutting-edge science and technology. Much of the establishment, Democratic and Republican alike, has embraced what the economists Sylvia Ostry and Richard Nelson call techno-nationalism and techno-fetishism, which both claim that US prosperity requires continued domination of these fields.

We’ve heard such fears and prescriptions before. In the 1980s, many people attributed the problems of the US economy to the proliferation of lawyers and managers and to a shortage of engineers and scientists; Germany and Japan were praised as countries with a better occupational ratio. Yet in the 1990s, their economies slackened while the United States prospered—and not because it heeded the warnings. Indeed, math and science education in US high schools didn’t improve much. Enrollment in law schools remained high, and managers accounted for a growing proportion of the workforce. The US share of scientific articles, science and engineering PhDs, and patents continued to decline, the service sector to expand, and manufacturing employment to stagnate.

Of course, the United States can’t count on the same happy ending to every episode of the “losing our lead” serial. The integration of China and India into the global economy is a seminal and unprecedented phenomenon. Could the outcome be different this time? Is the United States on the verge of being pummeled by a technological hurricane? In my view, the answer is no. Worries about the offshoring of R&D and the progress of science in China and India arise from a failure to understand technological innovation and its relation to the global economy. Innovation does play a major role in nurturing prosperity, but we must be careful to formulate policies that sustain rather than undermine it—for instance, by favoring one form of innovation over another.

Three levels of innovation

Innovation involves the development of new products or processes and the know-how that begets them. New products can take the form of high-level building blocks or raw materials (for example, microprocessors or the silicon of which they are made), midlevel intermediate goods (motherboards with components such as microprocessors), and ground-level final products (such as computers). Similarly, the underlying know-how for new products includes high-level general principles, midlevel technologies, and ground-level, context-specific rules of thumb. For microprocessors, this know-how includes the laws of solid-state physics (high level), circuit designs and chip layouts (midlevel), and the tweaking of conditions in semiconductor fabrication plants to maximize yields and quality (ground level).

Technological innovations, especially high-level ones, usually have limited economic or commercial importance unless complemented by lower-level innovations. Breakthroughs in solid-state physics, for example, have value for the semiconductor industry only if accompanied by new microprocessor designs, which themselves may be largely useless without plant-level tweaks that make it possible to produce these components in large quantities. A new microprocessor's value may be impossible to realize without new motherboards and computers, as well.

New know-how and products also require interconnected, nontechnological innovations on a number of levels. A new diskless (thin-client) computer, for instance, generates revenue for its producer and value for its users only if it is marketed effectively and deployed properly. Marketing and organizational innovations are usually needed; for example, such a computer may force its manufacturer to develop a new sales pitch and materials and its users to reorganize their IT departments.

Arguing about which innovations or innovators make the greatest contribution to economic prosperity, however, isn't helpful, for they all play necessary and complementary roles. Innovations that sustain prosperity are developed and used in a huge game involving many players working on many levels over many years.

Consider, for instance, the story of the key active component in almost all modern electronics: the transistor. A pair of German physicists obtained the first patents for it in the 1920s and ’30s. In 1947, William Shockley and two colleagues at Bell Labs built the first practical point-contact transistor, which Bell used only in small quantities. In 1950, Shockley developed the radically different bipolar junction transistor and licensed it to companies such as Texas Instruments, which at first implemented it in a limited run of radios that were used as a sales tool. Within two decades, transistors had replaced vacuum tubes in radios and TVs and spawned a whole world of new devices, such as electronic calculators and personal computers.

The German physicists’ discoveries began an extended process of developing know-how at a number of levels. Some steps involved high-level discoveries, such as the transistor effect, which earned Shockley and his colleagues a Nobel Prize. Other steps, such as those needed to obtain high production yields in semiconductor plants, called for lower-level, context-specific knowledge.

A similar complexity characterizes globalization. A variety of cross-border flows can be important to innovators—for instance, the diffusion of scientific principles and technological breakthroughs, the licensing of know-how, the export and import of final products, the procurement of intermediate goods and services (offshoring), equity investments, and the use of immigrant labor. Many kinds of global interactions have become more common, but not in a uniform way: international trade in manufactured goods has soared, but most services remain untraded. Of the many activities in the innovation game, only some are performed well in remote, low-cost locations; many midlevel activities, for example, are best conducted close to potential customers.

Where technomania goes wrong

Techno-nationalists and techno-fetishists oversimplify innovation by equating it with discoveries announced in scientific journals and with patents for cutting-edge technologies developed in university or commercial research labs. Since they rarely distinguish between the different levels and kinds of know-how, they ignore the contributions of the other players—contributions that don’t generate publications or patents.

They oversimplify globalization as well—for example, by assuming that high-level ideas and know-how rarely if ever cross national borders and that only the final products made with it are traded. Actually, ideas and technologies move from country to country quite easily, but much final output, especially in the service sector, does not. The findings of science are available—for the price of learned books and journals—to any country that can use them. Advanced technology, by contrast, does have commercial value because it can be patented, but patent owners generally don't charge higher fees to foreigners. In the early 1950s, what was then a tiny Japanese company called Sony was among the first licensors of Bell Labs' transistor patent, for $50,000.

In a world where breakthroughs travel easily, their national origins are fundamentally unimportant. Notwithstanding the celebrated claim of the author and *New York Times* columnist Thomas Friedman, it *doesn't* matter that Google's search algorithm was developed in California. An Englishman invented the World Wide Web's protocols in a Swiss lab. A Swede and a Dane started Skype, the leading provider of peer-to-peer Internet telephony, in Estonia. To be sure, the foreign provenance of such advances does not harm the US economy (see sidebar, "Case in point: Innovation in health care").

What is true for breakthroughs from Switzerland, Sweden, Denmark, and Estonia is true as well for those from China, India, and other emerging economies. We should expect—and desire—that as prosperity spreads, more places will contribute to humanity's stock of scientific and technological knowledge. The nations of the earth are not locked into a winner-take-all race for leadership in these fields: the enhancement of research capabilities in China and India, and thus their share of cutting-edge work, will improve living standards in the United States, which, if anything, should encourage these developments rather than waste valuable resources fighting them.

The willingness and ability of lower-level players to create new know-how and products is at least as important to an economy as the scientific and technological breakthroughs on which they rest. Without radio manufacturers such as Sony, for instance, transistors might have remained mere curiosities in a lab. Maryland has a higher per capita income than Mississippi not because Maryland is or was an extremely significant developer of breakthrough technologies but because of its greater ability to benefit from them. Conversely, the city of Rochester, New York—home to Kodak and Xerox—is reputed to have one of the highest per capita levels of patents of all US cities. It is far from the most economically vibrant among them, however.

More than 40 years ago, the British economists Charles Carter and Bruce Williams warned that "it is easy to impede [economic] growth by excessive research, by having too high a percentage of scientific manpower engaged in adding to the stock of knowledge and too small a percentage engaged in using it. This is the position in Britain today." [2] It is very much to the point that the United States has not only great scientists and research labs but also many players that can exploit high-level breakthroughs regardless of where they originate. An increase in the supply of high-level know-how, no matter what its source, provides more raw material for mid- and ground-level innovations that raise US living standards.

Techno-fetishism and techno-nationalism also ignore the implications of the service sector's ever-growing share of the US economy. Manufacturing, with just 12 percent of US GDP, accounts for some 42 percent of the country's R&D and employs a disproportionately large number of its scientists, technicians, and engineers. Services, with about 70 percent of US GDP, accounts for a disproportionately low one. But this doesn't mean that the service sector shuns innovation. As the economist Dirk Pilat notes, "R&D in services is often different in character from R&D in manufacturing. It is less oriented toward technological developments and more at codevelopment, with hardware and software suppliers, of ways to apply technology" to products. [3] Whatever proportion of resources a manufacturing economy should devote to formal research (or research labs) and to educating scientists, the appropriate proportion would be lower in a services-based economy.

Consider a particularly important aspect of the US service sector: its use of innovations in information technology. It simply doesn't matter where they were developed; the benefits accrue mainly to US workers and consumers because, in contrast to manufacturing, most services generated in the United States are consumed there. Suppose that IT researchers in, say, Germany create an application that helps retailers to cut inventories. Wal-Mart Stores and many of its US competitors have shown conclusively that they are much more likely to use such technologies than retailers in, for example, Germany, where regulations and a preference for picturesque but inefficient small-scale shops discourage companies from taking a chance on anything new. That is among the main reasons why since the mid-1990s, productivity and incomes have grown faster in the United States than in Europe and Japan.

Changing course

Since innovation is not a zero-sum game among nations, and high-level science and engineering are no more important than the ability to use them in mid- and ground-level innovations, the United States should reverse policies that favor the one over the other, and it should cease to worry that the forward march of the rest of the human race will reduce it to ruin.

One obvious example of its mistaken policies is the provision of subsidies and grants for R&D but not for the marketing of products or for the development of ground-level know-how to help the people who use them. Similarly, companies such as Wal-Mart have very large IT budgets and staffs that develop a great deal of ground-level expertise and even develop in-house systems. But none of this qualifies for R&D incentives.

Policies to promote long-term investment by providing tax credits for capital equipment and for brick-and-mortar structures seem outdated as well. The purchase price of enterprise-resource-planning systems, for example, is just a fraction of the total cost of the projects to implement them. Yet businesses eligible for investment-tax credits to buy computer hardware or software don't receive tax breaks for the cost of training users, adapting hardware and software systems to the specific needs of a company, or reengineering its business processes to accommodate them.

Immigration policies that favor high-level research by preferring highly trained engineers and scientists to people who hold only bachelor's degrees are misguided too. By working in, say, the IT departments of retailers and banks, immigrants who don't have advanced degrees probably make as great a contribution to the US economy as those who do. Likewise, the US patent system is excessively attuned to the needs of R&D labs and not enough to those of innovators developing mid- and ground-level products, which often don't generate patentable intellectual property under current rules and are often threatened by easily obtained high-level patents.

Thomas Friedman to the contrary, the world is hardly flat: China and India aren't close to catching up with the United States in the ability to develop and use technological innovations. Starting afresh may allow these countries to leapfrog ahead in some respects—building advanced mobile-phone networks, for example. But excelling in the overall innovation game requires a great and diverse team, which takes a very long time to build. Japan, for instance, began to modernize itself in the late 1860s. Within a few decades, it had utterly transformed its industry, educational system, and military. Today, the country's highly developed economy makes important contributions to technological progress. Yet after nearly 150 years of modernization, Japan remains behind the United States in the overall capacity to develop and use those innovations, as average productivity data show. South Korea and Taiwan, which have enjoyed truly miraculous growth rates since the 1970s, are still further behind. Do China and India have any real likelihood, at any time in the foreseeable future, of attaining the parity with the United States that has so far eluded Japan, South Korea, and Taiwan?

Complacency is dangerous, but fretting over imaginary threats impairs the ability to address real ones. A misguided fear of scientific and technological progress in China and India distracts Americans both from its benefits and from the important problems created by the integration of these two countries into the global economy—such as the soaring per capita fossil fuel consumption of more than two billion people. We do have much to worry about. Let's worry about the right things.

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