

Elements of Innovation

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Innovation is the development of new products, processes, or services. It has become a fundamental element in global economic competition. Innovation ultimately depends on a nation's knowledge, skills, and creativity, but government policies can play an important role in creating the conditions and the resources for innovation.

As innovation has grown more important for economic activity, there have been a number of efforts to conceptualize and describe it. Some efforts to capture the complex interactions that lead to innovation describe the process as a "national innovation system." There are many definitions of a national innovation system, but these definitions identify number of factors that make up a nation's capability for innovation and determine the rate and scope of innovation. In their simplest form, these factors combine to create new knowledge and then turn it into commercial activity. There are important similarities in how countries achieve innovation, but also unique national problems and initiative. Government policies that positively affect these factors can promote innovation, and slow or accelerate the pace of innovation.

Several different factors shape national capabilities for innovation. Among the most important are the stock and production of human capital, processes for knowledge acquisition, the ability to commercialize new knowledge, the presence of supporting infrastructures, and a country's openness to competition. Understanding these factors can help provide both a way to measure innovative capabilities and provide a guide for policy.

Human Capital: The first is human capital. Human capital is the skills and knowledge possessed by individuals. Human capital is created through education and experience. Both are important for the development of high technology, but advanced education plays a particularly important part. Economies with greater supplies of human capital will do better in the new global economic environment, and increasing the stock of human capital is an important goal for national policies. Many policy recommendations for building human capital focus on strengthening the entire education system, and a literate workforce is essential for a high tech economy, but if the goal is to increase the amount of innovation, government policies should focus on graduate research programs.

Research Universities: The primary source for technological innovation remains research universities and graduate research programs. Strong graduate programs are essential for building the human capital needed and are the leading source of the ideas and the workforce needed for technological innovation. Graduate programs produce scientific knowledge and expertise. Strong universities are a crucial element for building an innovative, high tech economy. Governments can accelerate the creation of human capital and speed their transition to high tech economies by establishing research universities.

In the 1960s, large central labs were the primary source for innovation. Now, the most dynamic element of the innovation process involves a combination of university research, startup firms, and financial support (from venture capital, corporations, or governments). A number of conditions are required for this to work, including the presence of advanced graduate research programs, a willingness by the host university to tolerate entrepreneurship and a flow of intellectual property, and effective mechanisms to link ideas with capital and, eventually, business experience. When this expertise is combined with financing and business experience, the result can be a greater output of innovative technologies. Well-known examples of this process include the research triangle in North Carolina, Silicon Valley and the area around MIT. These areas now serve as models for other regions of the United States and for efforts in other countries.

Skill/Resource Clusters: Research universities provide ideas and workers, but to turn these into economically valuable activities requires many other skills. These additional skills include legal and financial services and business and managerial expertise. When these skills are clustered – geographically located in relatively close proximity to each other – their economic benefits are maximized. The development of these skill/resource clusters around research universities provides real economic benefits. Clusters create communities of interlocking expertise that lower the costs and risks associated with innovation by ensuring that a range of needed skills can be easily found and readily accessible.

Entrepreneurial Culture: Innovation also works best when it occurs in the context of an entrepreneurial culture. An entrepreneurial culture accepts risk and failure and empowers individuals to conceptualize how research can be turned into marketable ideas. Entrepreneurship reflects the larger social and cultural preferences found in different societies, but there is some evidence that entrepreneurship can be learned. It can be encouraged and expanded through a legal and regulatory framework that supports risk-taking and does not penalize honest failures. The ability to see potential opportunities in the ideas created by research and the willingness to take the risks entailed in turning this knowledge into a business are crucial for making scientific research a contributor to economic growth.

Research and Development Funding: The OECD defines R&D as systematic creative work to increase the stock of knowledge and to devise new applications using this knowledge. It has three broad categories of activities: basic research, applied research, and development. Basic research is experimental or theoretical work undertaken to acquire new knowledge of underlying phenomena without any particular application or use in view.

Government support for research and development can be a crucial support for the acquisition of new knowledge. However, research and knowledge acquisition in itself will not generate economic growth. The new knowledge must be effectively commercialized. R&D investments can increase GDP, but there are also examples of nations that spent heavily on R&D without producing benefit (such as Japan or the UK in

the 1960s). A straightforward increase in R&D funding, for example, will not necessarily produce economic benefit if the result of increased research cannot be turned into commercial activities. The failure to effectively commercialize research has been a major handicap for many innovation policies.

In many instances, the private sector will contribute significantly to research and development, particularly in the development of new products or services. Government programs that encourage private sector investment in basic research can make a valuable contribution. Other aspects of R&D, however, are unlikely to attract private sector funding, even with government incentives. Since basic research produces general knowledge that is widely disseminated, a company that invested in basic research would not see an adequate return. Funding for basic research must usually come from the public sector. This is an important activity for government, as it is basic research that provides the new knowledge that will lead to innovation. A country could compensate for a lack of basic research by acquiring knowledge from external sources, but it might find itself at a disadvantage compared to nations with strong research capabilities.

Information Technology: For a few years at the beginning of the internet revolution, there was considerable debate among economists as to whether companies' investments in IT actually produced any benefit. It now appears that there was a lag between the acquisition of information technologies and the ability of individuals and companies to use it to increase their productivity. People had to learn how to use the new equipment. It now is clear that knowledge acquisition is easier because information technology has lowered the cost of acquiring information. The internet creates an immense online resource immediately accessible to researchers and entrepreneurs. Knowledge is accessible in new ways, and is easier to locate, store, and transfer. Expertise is also easier to locate. Collaboration is easier in the same firm or time zone, or in different ones. The improvement of telecommunications services and the promotion of access to and use of the internet to increase knowledge acquisition is one strategy for government policy that can provide both immediate and long-term benefits.

Technology Transfer: Technology transfers from external sources have proven to be vital for economic progress in less-mature economies. Technology transfer provides the skills and intellectual property that allow businesses to become more productive and competitive. These transfers are closely tied to foreign direct investment – the former head of the WTO called FDI the world's "best mechanism for transferring technology."

Commercialization of New Knowledge: Research by itself does not create wealth. The ability to turn research into commercial activity is what makes innovation different from research. The classic view of commercialization is that it is entrepreneurs who are primarily responsible for this activity, but in fact commercialization is much more diffuse, with universities seeking to license the product of their researchers and large corporations developing a range of strategies (licensing, co-development, or outright acquisition of innovative start-up firms) to obtain new knowledge for commercial use.

Private Sector Financing/VentureCapital: The presence of a supportive financial

system is one of the benefits of the development of clusters of business and entrepreneurial skills required for growth. The financial process to support innovation is more complex and requires specialized financial services that support innovation along all phases of the path from research to product. It involves the venture capital that allows entrepreneurs to establish firms that take the ideas from research and try to turn them into products. These venture capital firms have special skills and a tolerance for risk not usually found in banks. It also requires continued financing once the firm is established to allow the new company to continue to operate until it can depend on revenue from sales. Along with financial support, the new company can also benefit from access to business skills and advice provided in tandem with financing.

Venture capital undertakes high risk investments that offer the promise of equally high returns. It is crucial for the startup companies that seek to exploit new ideas from research, because these are usually new, unproven, small, and private, and thus unable to access traditional financing such as bank loans or stock sales on exchanges. The benefits of venture capital are widely recognized. Venture capital often covers only the first phase of commercialization, but it is an essential first step. Many governments either try to foster the development of venture capitalists or create governmental entities that mimic the activities of venture capitalists by providing financing to new, high risk enterprises, or by attracting existing venture capital funds to undertake activities in their region or country.

Supporting Infrastructures: Governments can increase innovation and attract investment by developing the public infrastructures needed for commercial activity. These include the “hard” infrastructure (transportation, electricity, communications), but also the intangible or “soft” infrastructure (legal system, regulations, financial system) that provide the conditions for economic growth. In many cases – particularly in soft infrastructure – these are goods and services that only the government can supply.

Physical Infrastructure: The quality of physical infrastructure is a key determinant for investment and for productivity. The creation of physical infrastructure is a traditional development tool. Physical infrastructure for transportation and communications are important – an isolated cluster that is poorly linked to the global economy will not perform well – but an adequate and reliable supply of electrical power is now a critical component for high tech industries. The experience of countries in the early stages of development, such as China, suggests that a strategy for building a high tech economy is best served if governments concentrate scarce funding for physical infrastructure on the emerging geographic clusters that will produce innovation. In the short term, this investment strategy will be inequitable, as some areas will receive less funding, but in the long term, it will produce faster economic growth.

“Soft” Infrastructure: We are accustomed to the idea of the physical infrastructure requirements of economic activity – transportation systems (roads, bridges, harbors, airports) telecommunications, and electrical power generation. Soft infrastructure is comprised of the laws, capital markets, and culture that enable commercial activity and turn research into innovation and innovation into economic activity. The quality of a

nation's soft infrastructure has at times been overlooked, but these intangible factors are as important as physical infrastructure for economic growth. Government policies are the primary determinant of "soft infrastructure."

Improvement in soft infrastructure is closely tied to administrative reform and the adoption of best practices derived from other nations' experiences. The development of an adequate corpus of laws and regulations for intellectual property, bankruptcy, competition, and other business practices is the basis for soft infrastructure. Enforcement of these laws in a transparent and equitable fashion by regulatory agencies and an effective court system are also necessary. The effective administration of a financial system is closely tied to this, as adequate laws and rules for capital markets will increase the supply and lower the cost of investment for economic development. Countries with a better soft infrastructure have a long-term advantage, and governments can take steps to improve their soft infrastructure by undertaking a series of reforms, often difficult, that produce better governance.

Openness to Competition: There is a correlation between long-term success in building an innovative economy and in that economy's openness to competition. The reason for this is that over the long term, competition leads to the more efficient use of resources. This can seem counterintuitive, and an engineering model, where investment and production decision are made by fiat, can superficially seem more efficient. This latter approach substitutes administrative and political processes for broadly distributed private-sector decision-making and market disciplines.

Openness to competition has implications for both domestic law and foreign trade. Domestically, privatization of state monopolies increases competition. Laws that block anticompetitive practices, such as cartels or monopolies, also enhance economic performance. Deregulation that eases the burden of opening a new business increases competition and speeds innovation.

One important reform involves trade policies. Those countries that are open to foreign trade and foreign investment appear to grow faster. This is a considerable change from the import substitution model used by many countries to an industrial model. In that model, national industries were sheltered from competition, particularly foreign competition. The import substitution strategy no longer works. This is because countries have greater access to resources, including knowledge and financing, and because their national companies learn to compete in the global market. Participation in the larger global market makes their own national efforts more efficient.

Debates over the benefits of competition versus more interventionist economic policies go back to the global depression of the 1930s, when the market orthodoxy of classic economics failed as a guide to policy and many economists and policy makers concluded that market economies would not produce positive social outcomes. They believed that government management of the economy could avoid the wastefulness of private markets. This engineering or technocratic approach remains attractive to many countries. It can speed growth in the initial stage of development, but once economies mature, it

may become an obstacle.

The government-directed model appears less efficient as economies become more developed and the issue is no longer to create new productive assets but to find better ways to use existing assets. In the U.S., private initiatives provide most of the impetus and direction for growth in the American economy. U.S. policies have emphasized less intrusive governments, fewer regulations, privatization, and more reliance on markets and competition among private entities. This approach reflects the questioning of Keynesian-inspired macro-economic management that had shaped policy until the 1980s. Some analysts attribute the U.S. success in innovation and economic growth to the absence of explicit growth policies, but others question the application of these policies (sometimes known as the “Washington consensus”) in other countries.

The U.S. approach stands in contrast to Europe, China, or Japan, where the government plays a prominent role in investment decisions for both government and private sector efforts. Other countries have relied on heavy public investment in infrastructure, human capital, and low cost financing for companies and entrepreneurs to expand their productive capabilities. Some have also used financial incentives to attract foreign investment in an industrial capacity to expand research. These policies appear to work best (at least initially) in developing economies where resources are under-utilized and markets are inefficient.