# NATIONAL INNOVATION POLICIES:

## WHAT COUNTRIES DO BEST AND HOW THEY CAN IMPROVE

Global Trade & Innovation Policy Alliance

JUNE 2019

# About the Global Trade and Innovation Policy Alliance

The Global Trade and Innovation Policy Alliance (GTIPA) is a global network of independent think tanks that are ardent supporters of greater global trade liberalization and integration, deplore trade-distorting "innovation mercantilist" practices, but yet believe that governments can and should play important and proactive roles in spurring greater innovation and productivity in their enterprises and economies. Member organizations advocate and adhere to research and policy consistent with a core Statement of Shared Principles.

The Alliance represents a network of like-minded think tanks who will have opportunities to collaborate on events, research, and reports while enjoying a platform that highlights and cross-pollinates member organizations' work on trade, globalization, and innovation policy.

Think tanks interested in joining the Alliance should contact Stephen Ezell, vice president for global innovation policy at the Information Technology and Innovation Foundation, at sezell@itif.org.

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# Introduction

The Global Trade and Innovation Policy Alliance (GTIPA) is a global network of 34 independent, like-minded think tanks from 25 nations throughout the world that believe trade, globalization, and innovation—conducted on market-led, rules-based terms—maximize welfare for the world's citizens. The Alliance exists to collectively amplify each member's voice and enhance their impact on trade, globalization, and innovation policy issues while bringing new scholarship into the world on these subjects. This volume provides GTIPA members' perspectives on what their nations are doing best when it comes to national innovation policy, and where there is the greatest opportunity for improvement. The goal of this report is to provide a profile of member countries' national innovation policies, and a comparative analysis of where the greatest strengths and opportunities for improvement lie. It also provides examples of specific innovation policies that have proven successful and other nations may therefore wish to adopt.

The classic definition of innovation is the improvement of existing, or the creation of entirely new, products, processes, services, and business or organizational models. Put simply, innovation is about the creation of new value for the world. Or, as the innovation evangelist John Kao frames it more aspirationally, innovation refers to the transformation of existing conditions into preferred ones.

Innovation matters because it's the foundational source of long-term global economic growth and improvements in quality of life and standards of living. For instance, the U.S. Department of Commerce reported in 2010 that technological innovation can be linked to three-quarters of the U.S. growth rate since the end of World War II. A different study attributes approximately 50 percent of U.S. annual gross domestic product (GDP) growth increases to innovation. Similarly, two-thirds of United Kingdom private-sector productivity growth between 2000 and 2007 resulted from innovation. And differing innovation rates explain differing levels of per-capita income across nations. When Klenow and Rodriguez-Clare decomposed the cross-country differences in income per worker into shares that could be attributed to physical capital, human capital, and total factor productivity, they found that more than 90 percent of the variation in the growth of income per worker depends on how effectively capital is used (that is, innovation), with differences in the actual amounts of human and financial capital accounting for just 9 percent. And while the private rates of return from innovation (technically, from research and development (R&D) investments) have been estimated at 25 to 30 percent, the social returns from innovation are typically two to three times larger than the private returns. In other words, the benefits from innovation spill over to society at large.

Thus, innovation matters greatly to the world economy. But maximizing the output of innovation globally requires two key conditions: First, countries must implement effective policies to maximize their own outputs of innovation. And second, the global economic and trade system must allow innovation-based industries to flourish by granting access to large international markets, confronting excessive non-market-based competition, and providing robust intellectual property (IP) protections. While both factors matter, this report focuses on the former.

Countries' innovation strategies must coordinate disparate policies toward scientific research, technology commercialization, information technology (IT) investments, education and skills development, tax, trade, IP, government procurement, and regulatory policies in an integrated fashion that drives economic growth. As Finland's National Innovation Strategy argues, it's vital that nations' innovation strategies comprehensively address a broad set of policy issues because "piecemeal policy measures will not suffice in ensuring a nation's pioneering position in innovation

activity, and thus growth in national productivity and competitive ability." As ITIF wrote in its report "The Global Flourishing of National Innovation Foundations," at least 50 nations have now articulated national innovation strategies; and most have even created special agencies or foundations to maximize the innovation output of their countries' enterprises and organizations. Ultimately, countries' innovation policies aim to explicitly link science, technology, and innovation with economic and employment growth, effectively creating a game plan for how they can compete and win in innovation-based economic activity.

This report summarizes what 23 nations and the European Union are doing best in innovation policy, and where they have the greatest room for improvement. The first thing that stands out is many countries—including Chile, Ghana, Honduras, and the United Kingdom—have established government agencies, councils, and organizations specifically responsible for innovation. For instance, Chile created a new National Office of Productivity and Entrepreneurship; Ghana created a Presidential Advisory Council on Science, Technology, and Innovation; and the United Kingdom established UK Research and Innovation to direct the nation's investments in research and innovation funding. Conversely, the lack of such an entity was identified as a weakness in American, Malaysian, and Italian innovation policy.

Several countries—including Argentina, Canada, Chile, China, Italy, Korea, and Poland—have implemented strong and innovative tax measures, such as more generous R&D tax credits, investment incentives, collaborative tax credits—which offer more generous incentives for industry-funded research occurring at universities—and patent boxes that tax profits from products deriving form new IP at a lower rate. Chile offers a flat 46-percent R&D tax credit. In Canada, Ontario has introduced a collaborative tax credit and Quebec has introduced a patent box. China offers a patent box that lowers the tax rate on qualifying R&D to between 0 and 12.5 percent. Italy offers super-depreciation for investments in new capital goods, tangible assets, and intangible assets such as software and IT systems; a tax credit on incremental R&D costs; and a patent box. Lack of tax incentives was identified as a German weakness, and a U.S. weakness is its collaborative R&D tax credit applies only to energy-sector collaborations. Beyond taxes, Poland has introduced innovation vouchers and loan programs in an effort to specifically stimulate innovation by small and medium-sized enterprises.

A number of countries have made efforts to improve their regulatory environment in support of innovation. Argentina and Chile introduced one-day registration for new businesses. Korea introduced a regulatory sandbox covering all industries—including information and communications technology (ICT), energy, and fintech—whereby no process of deliberation or approval is to exceed three months. The Philippines' Central Bank is experimenting with a regulatory sandbox for fintech. Chile produced the report, "Regulatory Policy in Chile," seeking to simplify and harmonize relevant regulations and improve its efficacy, predictability, compliance, and supervision. However, conversely, weak regulatory environments were cited as barriers to innovation in Canada, India, Korea (hence its introduction of the regulatory sandbox approach), Honduras, and South Africa. These countries noted their stringent regulatory environments as the most constraining innovation in their fintech and life sciences industries.

Colombia, the European Union, Mexico, Pakistan, and Taiwan all have initiatives to leverage open data as a platform for innovation. Colombia's portal has more than 10,200 datasets from 1,184 public institutions. Mexico's National Digital Strategy has more than 40,417 datasets from 278 public entities available on its open data portal. The European Union's Ministerial Declaration on e-Government pledges to link-up members' public e-services and adopt a "once-only" principle

(i.e., ask citizens for data only once). Taiwan is implementing an "Action Plan of Open Data" in which government organizations, at every level, are required to have an open data committee and establish open-dataset goals. The country has almost 40,000 open datasets, and regularly holds events such as Hackathons, Data Jams, and Datapaloozas to stimulate open innovation.

Several countries have introduced strategies to drive leadership in emerging information technology application areas. Canada has invested, established agencies, and developed strategies to spur growth in artificial intelligence (AI) and quantum computing. The European Union has developed an AI strategy and directed each of its individual member states to do the same. Among the countries represented in this compendium, that covers France, and Korea is also developing an AI strategy.

Several countries have defined strategies to ensure leadership in manufacturing digitalization, or "Industry 4.0," including Bangladesh, Italy, Malaysia, Mexico, Sweden, and the Philippines. For instance, in 2017, the Filipino government launched the Inclusive, Innovation-led Industrial Strategy, which represents a new approach to industrial policy for a nation anchored in competition, innovation, and productivity.

Several countries report favorable trends in their national R&D intensity (their countries' R&D investments as a share of GDP). For instance, Korea's national R&D intensity grew to 4.55 percent in 2017, second in the world; China's grew to 2.19 percent, from just 0.90 percent in 2000; and Sweden's remained a robust 3.3 percent, although this was down from the country's 3.9 percent in 2000; while Germany eclipsed 3 percent in 2017, a steady rise from its 2.4 percent from 2000. Yet, for most other nations in this report, faltering R&D investments is a lament, something that is true for both developed nations such as Canada, the United States, and the United Kingdom, and developing countries, including Argentina, Chile, Colombia, Mexico, and South Africa. Canada's national R&D intensity actually fell by over 20 percent from 2.0 percent in 2001 to 1.6 percent in 2014. The United Kingdom invests a meager 1.67 of its GDP in R&D, ranking 11th among European nations; France's investments have been flat for years. U.S. public investment in R&D is down dramatically. And Latin America remains a laggard in global R&D investment. As a whole, Latin American nations invest just 0.83 percent of their GDP in R&D, less than half the average of (non-high-income) East Asian and Pacific nations (1.96 percent), and even below such other country blocks as Central Asia. Bolstering their nations' investments in R&D would be perhaps the single most important step Latin American countries could take toward turbocharging their innovation economies.

It's difficult to achieve innovation without protecting ideas. Robust IP rights—an effective protection and enforcement mechanism—provide innovators security in the knowledge they can capture a share of the returns from their risky, expensive, and uncertain investments in innovation, and then be able to turn the profits from one generation of innovation into financing to create the next. While some members have reported improvements to their countries' IP environment in recent years, notably Mexico, many reports point to weak IP environments inhibiting innovation. Reports from Bangladesh, Canada, China, India, Malaysia, and South Africa in particular note difficult IP environments. For example, in India, Malaysia, and South Africa, governments have introduced (or are considering introducing) compulsory licenses that would force enterprises to disclose the novel IP behind their innovative drugs. Thus, it is perhaps not a surprise that after Brazil and Canada weakened drug patents, R&D investment by pharmaceutical companies declined by 75 and 34 percent respectively. And the number of clinical trials declined by 60 percent in the five years after Colombia threatened compulsory licensing in the life sciences (a position the new Duque government has since retracted). Another concern for many nations is the need to strengthen

workforce-training systems, especially science, technology, engineering, and mathematic (STEM) talent. The profiles of innovation policies in Chile, Germany, Italy, Korea, Malaysia, Mexico, the Philippines, Sweden, and Taiwan all cite educating high-level talent, fielding highly skilled workforces, and ensuring a sufficient level of graduates and workforces as a significant concern. For some countries, such as German, Sweden, and Taiwan, the concern is more about a lack of STEM professionals specifically. For others, there are broader concerns related to human capital, ensuring sufficient levels of educational attainment, enhancing both individual and broader workforce-level preparedness for Industry 4.0, or the coming changes that will be wrought by digital transformation. Clearly, many countries are facing a lack of talent, and in several cases, difficulty bringing it into their countries as well.

Achieving effective technology transfer and commercialization of new discoveries from universities, research institutions, and national laboratories to the private sector has been cited as a challenge for a number of countries, developed and developing alike. The Italian submission has noted that despite its high-quality academic research, Italy performs relatively poorly in terms of patent submissions and time to market. Similarly, a recent study of Sweden's life-sciences industry lamented, "There is currently no effective platform to industrialize ideas from higher education institutions in the life sciences sector." Country profiles of Canada, India, and the Philippines also reference the challenge of creating stronger linkages between industry and academia, or between knowledge producers and consumers. Only the U.S. country profile reports this as a systemic strength, noting that America's Bayh-Dole Act (which gives universities rights to innovations stemming from federally funded R&D) and the Small Business Innovation Research Program (SBIR), a program designed to help small businesses commercialize technologies stemming from federal R&D funding, have proven effective in tackling this challenge. Notably, America's Bayh-Dole legislation has been copied by more than two-dozen countries and its SBIR program by at least 18 worldwide.

Several other weaknesses, or challenges, that have been cited by multiple countries are worth noting. Reports from Colombia, Korea, Poland, the Philippines, and Taiwan have all cited the need to reform public procurement systems to either favor more innovative vendors, give small businesses better opportunities to compete, or introduce more competition into the tender process. For some countries, including Bangladesh, Ghana, Honduras, India, and the Philippines, the challenge isn't just about government procurement, but broader regulatory weaknesses, including slow government processes for registering new businesses, approving uses of new technologies, and simply removing restrictions and burdensome regulations and procedures from sectors such as telecommunications, transport, and professional services. Finally, some members, including in Colombia and Poland, believe a weak ICT infrastructure is significantly inhibiting their countries' innovation potential, while others, such as members in Pakistan and the Philippines, report significant improvements in this regard have tremendously advanced their national innovation environments.

In conclusion, these 24 reports of countries' three best innovation policies and three greatest opportunities for improvement represent a comprehensive, deep, and insightful catalog of best innovation policies and practices, revealing how countries—developed and developing alike—are trying to deal with similar opportunities and challenges. There's something to be learned from each country profile, and hopefully this volume will represent a practical tool for innovation policymakers to reference some of the most cutting-edge practices being applied on the world stage today.

# Introduction Endnotes


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# Argentina

*By: Martin Krause, Libertad y Progreso, and Stephen Ezell, Information Technology and Innovation Foundation*

| Comparative Strengths | Comparative Weaknesses |
|---|---|
| 1. Increasing Recognition of the Role of Innovation in Economic Growth<br>2. Passage of the Entrepreneurs' Law and the Knowledge Economy Law strengthens Argentina's Innovation and Entrepreneurship Environment<br>3. Slow Improvement of Institutional Quality | 1. An Unstable Fiscal and Monetary Environment Deters SMEs' Growth and Investment in R&D<br>2. Intellectual Property Protections and Enforcement Remain Relatively Weak<br>3. Failure to Join the Information Technology Agreement |

## Strengths

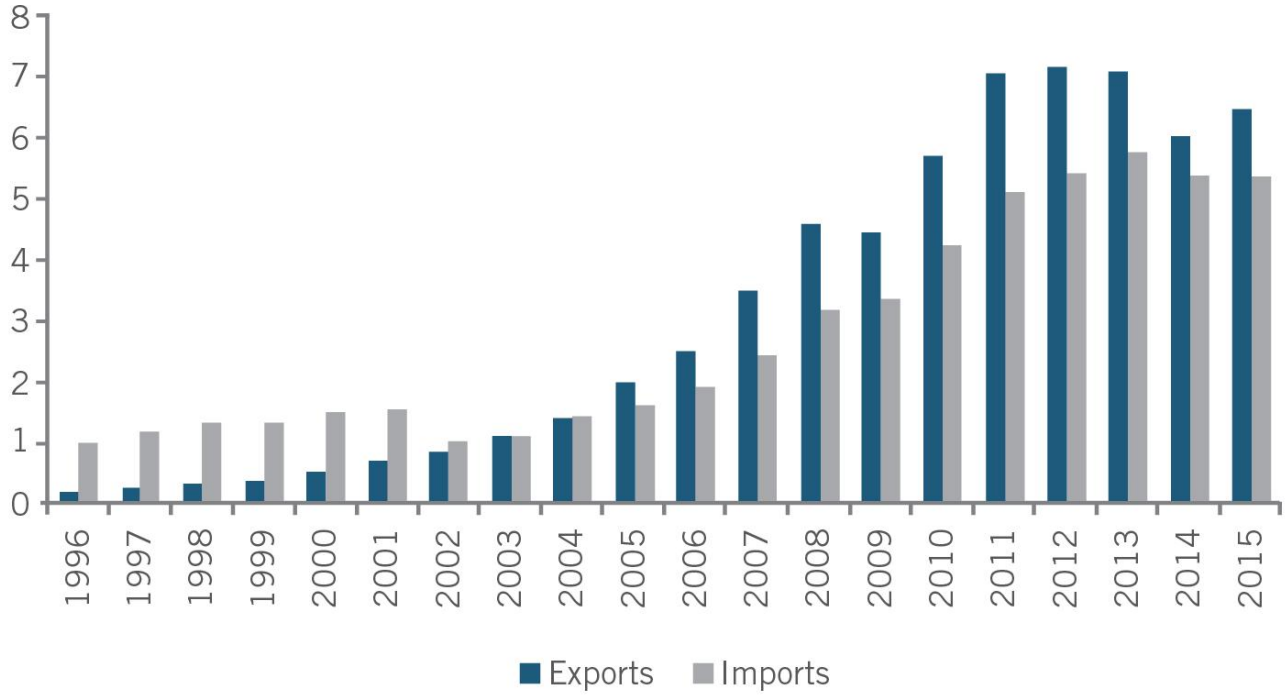
### 1. Increasing Recognition of the Role of Innovation in Economic Growth

The Argentine government has recognized the role of innovation in economic growth, and sought to promote knowledge-based services, including software development and professional services. The objective is to build a new economic structure, characterized by technological innovation and high-value-added services. The Macri government has produced a document entitled "A New Argentina: Towards the Economy of the Future," wherein, among other areas, it highlights:

- The knowledge economy has an enormous potential to boost the growth of Argentina given the local and global economic context, increasing productivity and job creation.
- Argentina is already a regional player in activities related to the knowledge economy, with an important base of local companies that sell globally, but faces multiple challenges in strengthening its competitiveness.
- The country already has a solid ecosystem of knowledge-based services, but it's necessary to empower them and level the playing field to position Argentina as a global knowledge economy hub.

Knowledge-based services are the fastest growing exports in Argentina, growing from $151 million in 1996 to $6.5 billion in 2015, as figure 1 shows. These exports were the second-most important export sector after soybeans, reaching 9.1 percent of exports. These activities already employ 1.3 million people in high-quality, well-paying, and formal jobs.

**Figure 1: Argentine Commerce in Knowledge-based Services, 1996–2015 ($ Billions)[1]**




In addition to knowledge-based services such as accounting, legal, and engineering, Argentina has an increasing capacity in research and development (R&D). R&D exports have grown steadily in the last 20 years, reaching $505 million in 2015. Clinical research is particularly important, especially in activities slightly less intensive in knowledge, such as clinical trials. However, in the most complex activities there are several Argentine companies that export R&D services abroad, such as Tenaris, INVAP, and Satellogic. There are also Argentine companies that export R&D incorporated into products in very knowledge-intensive areas, such as biotechnology (e.g., the companies Bioceres and Don Mario).

Argentina also boasts an important innovative capacity in the area of agricultural biotechnology industries, and, supported by a favorable regulatory environment, is a world leader in activities such as transgenic soybeans. The Argentine pharmaceutical industry is a leader in exports in the region, and although it has developed experience in reverse engineering and biosimilar production, there is a potential to advance in the value chain and begin to produce R&D for new medicines. Argentina is the fourth-largest producer and exporter of content for television, and recent investments in agro-industry, biofuels, creative industries, professional services, and tourism, among others, are expanding production capacity for local and global markets. Strategies as articulated in the report "A New Argentina: Towards the Economy of the Future" show the Macri government is focused on and has taken important steps to bolster Argentina's innovation-based industries.

## 2. Passage of the Entrepreneurs' Law and the Knowledge Economy Law Strengthen Argentina's Innovation and Entrepreneurship Environment

In 2017, Argentina passed the Entrepreneurs' Law (Ley de Emprendedores), which took a number of steps to improve the entrepreneurship and innovation environment in Argentina. The law

consists of a number of measures aimed at increasing entrepreneurial and investment activity in the country by improving the ease of doing business, providing new channels of financing, and offering attractive new tax breaks and incentives for those interested in investing in Argentine start-ups and venture capital funds.[2] Learning from Chile's "Law of Business in One Day," the Entrepreneurs' Law allows entrepreneurs to set up their businesses via the Internet in as little as 24 hours with a simplified business entity (SAS) model, whereas the process previously took six months to a year. The law also created the Fiduciary Fund for the Development of Venture Capital, which finances ventures and venture capital institutions, and in 2018 contributed up to 40 percent (of the total capital committed) to three venture capital funds.[3] The law also established a formal registry of venture capital institutions, which serve as a place for Argentina's various institutions and investors to register and share information. The law also gives investors more incentives to invest in qualified start-ups or venture capital funds. Seventy-five percent of any investment in a SAS company or SAS-accredited investment fund becomes tax-deductible for up to 10 percent of the investor's annual profits. Investors who choose to invest in less-developed areas, with lower access to capital, are eligible for an enhanced deduction of up to 85 percent.[4]

In 2019, Argentina's Congress sanctioned a law for "the promotion of the knowledge economy" covering the following areas: software and IT services, audiovisual production, biotech, geological and prospective services, professional services, nanotech, aerospace, and digital automation. It grants benefits such as "fiscal stability" for national taxes, deduction of some taxes on labor, a fiscal credit for the income tax of payroll contributions, a 15 percent income tax (the general rate is 35 percent) for those who keep the present payroll, and other measures.

Argentina is already home to some of Latin America's biggest start-up success stories. In fact, four out of the region's nine most valuable "unicorn" technology companies hail from Argentina: Mercado Libre, Despegar, Globant, and OLX. Nevertheless, the Entrepreneurs' Law is poised to play an important role in continuing to improve the country's innovation environment.

Argentina's Instituto Nacional de Tecnología Industrial (National Institute of Industrial Technology, or INTI), provides technology extension services for the country.[5] INTI has provided these services since 1957.[6] Argentine SME manufacturers also receive support from the Secretariat of Entrepreneurs and Small and Medium Enterprises (SEPYME).[7] Argentina's Ministry of Science, Technology, and Innovation also plays a role in promoting innovation and productivity in Argentina's SME sector.[8]

### 3. Slow improvement of institutional quality

Fundación Libertad y Progreso and Relial (Red Liberal de América Latina) publish every year the Index of Institutional Quality, evaluating 190 countries on the framework of rules for political and market activity.[9] Argentina fell from 44 in 1996 to 142 in 2016. It has then recovered to 112 in 2019. Nevertheless, it still has a long way ahead to recover lost positions. Further improvement of institutional quality will create new opportunities for entrepreneurial activity with better and reliable rules.

## Weaknesses

### 1. Unstable fiscal and monetary environment and slow growth of R&D

Argentina's government has been living beyond its means for years. Its fiscal deficit reached 7 percent of GDP in 2017 and government expenditures grew from an average of 30 percent of

GDP before 2002 to 47 percent in 2017, which has risen to 45 percent now. This leads to a constant scraping of funds that sooner or later significantly impact SMEs. Also, starting this year, a new tax on the export of services was introduced, particularly hurting the export of software and professional services. The tax does not apply to exports below $600,000 a year, excepting SMEs, but hampers the Argentina Knowledge Economy. Argentina has a tax pressure close to developed countries which suffocates private business; it ranks 169 among 190 countries in the Paying Taxes category of the World Bank's Doing Business Index.[10]

Monetary instability reduces the availability of credit for companies and prevents the existence of deeper capital markets to finance startups and investment. Eventually, this has an impact on R&D. As the World Bank's Kristina Thorn has noted, "Comparative data reveal that Argentina underinvests in R&D. Notably, private sector involvement in R&D is very low by international standards. In part, this can be attributed to the prevalence of SME enterprises with few innovative sales."[11] In fact, Argentina invests just 0.6 percent of its gross domestic product into R&D annually, which is lower than even the average for all Latin American and Caribbean nations.[12] If Argentina wishes to enhance its ability to contribute to the global innovation economy, it needs to invest more of its resources into R&D and original scientific discovery.

## 2. Intellectual Property Protections and Enforcement Are Relatively Weak

Argentina remained on the United States Trade Representative Office's Priority Watch List in its 2018 *Special 301 Report* due to limited scope of patent subject-matter eligibility, long patent pendency periods, and inadequate protection against unfair commercial use and unauthorized disclosure of undisclosed test and other data submitted to the government in conjunction with its lengthy marketing approval process.[13] The report also critiques a lack of sustained enforcement efforts, including under the criminal laws, sufficient to have a deterrent effect on intellectual property (IP) theft.[14] That said, Argentina's score on the 2019 *International IP Index* did improve as a result of positive IP reforms, including strengthening its international cooperation on IP, becoming a member in Patent Prosecution Highways, and, in 2018, its introduction of the Cooperative Patent Classification system. The country has also taken proactive steps to reduce its patent backlog.[15] Still, Argentina ranked 40th out of 50 countries in the study.

Argentina could benefit from further enhancements to its intellectual property rights (IPR) environment. The improvement of IPR legislation to comply with the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) did result in greater innovation in Argentine industries. Argentina has many sectors that would benefit from an improvement in IPR protection today, among which are the genetic development of seeds, the cloning of polo horses, the software industry, local brands of recognized prestige, film production and television, musicians and art creators, and even the local pharmaceutical industry itself, which has the capacity to innovate and, in fact, does—although it often protects its innovations in other countries. Finally, the requirements to improve the protection of IPR should not be taken as a "cost" of the negotiation, but as an institutional improvement that would be worthwhile even without any commercial treaty. This would boost innovation in Argentina by improving and multiplying R&D efforts, opening the door to the enormous innovative and creative potential that the country has.

## 3. Failure to Join the Information Technology Agreement

In 2015, Argentina's tariffs and taxes on smartphones were the second-highest in the world. In fact, in 2014, the country's tariffs on information and communications technology (ICT) products

covered under the Information Technology Agreement (ITA)—a trade agreement that eliminates tariffs on hundreds of ICT products—was 12.4 percent. Argentina's economy would stand to grow greatly if it were to join the ITA and eliminate tariffs on these innovation-enhancing capital goods. In fact, ITIF's report, "How Joining the Information Technology Agreement Spurs Growth in Developing Nations," finds that Argentina's economy would be 1.52 percent larger in the 10th year after it were to join the ITA, with the county in that 10th year generating tax revenues from the expanded economic growth at a rate 133 percent the amount of tariff revenue forgone in that year.[16] Beyond the economy, as Santiago Urbiztondo, an economist at the Foundation of Latin American Economic Investigations, put it, "The impact [of the tariffs] on employment certainly has been very negative."[17] That's because if companies have to spend more on ICTs, then they can spend less on employees; and also because they are less competitive and productive, they can't grow as fast, meaning they can't hire more.

In partial recognition of this, in January 2017, Argentina's Ministry of Production—after a review of the impacts of a tariff reduction on certain technology imports—officially announced that, as of April 2017, the import tariff on personal computers, notebooks, and tablets would be eliminated. Officials are still expecting the prices of those products to drop as much as 50 percent.[18] They are estimating the tariff elimination will help create more than 15,000 new jobs related to commercial and repair activities and in other industries benefited by the access to cheaper ICTs within three years. While this certainly represents a step in the right direction, Argentina could go further by joining the ITA in full, and comprehensively eliminating tariffs across a far broader swath of ICT inputs and finished goods.

# Bangladesh

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| Comparative Strengths | Comparative Weaknesses |
|---|---|
| 1. Digital Bangladesh 2021 | 1. Lack of Implementation of IP Rights |
| 2. Mobile Financial Services | 2. Software Piracy |
| 3. Online Education | 3. Non-conducive Business Ecosystem |

## Strengths

### 1. Digital Bangladesh 2021

The Digital Bangladesh Vision 2021 agenda aims to empower Bangladesh to create solutions to development challenges and foster a progressive environment for innovation. Under the agenda of Digital Bangladesh, driven by policy support and widespread digitization in the public and private sectors, the country has experienced exponential growth in Internet connectivity, mobile-phone usage, information and communication technology (ICT) export earnings, and use of ICT in education and accessibility of public services. As of April 2018, the number of mobile users in Bangladesh had grown to more than 150 million, from just 20 million 10 years earlier. The number of Internet subscribers in Bangladesh stood at 86 million, while the rates of teledensity and Internet density were 91 percent and 50 percent, respectively. According to a report by the GSM Association, Bangladesh has the potential to emerge as the 10th largest global Internet user by 2020. To facilitate unremitting access, the government has plans to develop the ICT infrastructure and, in this regard, 8,000 km of optical fiber cable has already been installed across the country. In association with the vision of Digital Bangladesh, the a2i Public Service Innovation Lab was established to ensure affordable, reliable, and uncomplicated access to quality public services through the harnessing of digital resources. The a2i (short for access to information) Lab helps government officials analyze and redesign workflows within and between ministries in order to optimize end-to-end processes and automate non-value-added tasks. It has established over 5,000 Digital Centers providing Internet access throughout the country. As a result, citizens can access hundreds of both free public services (such as land records, birth registration, telemedicine, life insurance, passport and overseas job applications, etc.) and private services (mobile financial services, assisted rural e-commerce, insurance, various types of computer and vocational training, etc.).

### 2. Digital Financial Services

Digital financial services in Bangladesh, consisting of both mobile financial service (MFS) and agent banking, are rapidly flourishing through a massive technological transformation. However, among the two methods, MFS is dominant in terms of the number of users. No other country has as many mobile-banking users as Bangladesh. Those previously unbanked and underbanked have

come under financial inclusion through various mobile-phone services due to the acclimatizing steps taken by Bangladesh's government and central bank. The government has facilitated the growth of mobile banking, launched in 2010. By May 2018, the average daily transactions through mobile banking amounted to more than BDT 1,058 crore. BKash, one of the leading mobile financial service providers, has recently initiated a strategic partnership with the operator of Alipay, the top third-party payment platform globally. Another leading initiative, Strengthening Women's Ability for Productive New Opportunities (SWAPNO), was inaugurated by the United Nations Development Program (UNDP), Bank Asia, and the Bangladesh government, and facilitates digital financial inclusion and literacy for extremely poor individuals. According to a report by UNDP, Bangladesh's accelerated spread of digital financial services is run by more than 750,000 mobile money agents and over 3,200 agent banking outlets. According to Bangladesh Bank, 18 banks currently provide digital financial services, while 767,768 mobile money agents are operational with 56.9 million registered users, 30.7 million active accounts, and BDT 1,038 crore (roughly U.S. $123 million) in average daily transactions. This has been enabled through better mobile phone access and mobile broadband usage in remote areas.

### 3. Online Pre-university Education

Bangladesh has a number of online platforms to provide primary, secondary, and skill-development programs for individuals. The government of Bangladesh is also pursuing initiatives that ensure primary and secondary educational resources are available online. Online platforms such as Shikkhok.com, BYLCx, and the innovative 10 Minute School are leading the way. Shikkhok.com has a panel of teachers who are experts that have excelled in their own educational fields. BYLCx provides the opportunity to learn in-demand skills to mitigate the existing gap and discrepancies between employer-valued skills and employee skills. The 10 Minute School is an online platform that incorporates both of these initiatives to an extent and engages technological innovation, digital inclusion, and affordable Internet connectivity to offer comprehensive study solutions to students, at a pre-university level. The 10 Minute School incorporates digital and entrepreneurial skill development alongside the academic curriculum to enable people to become more accustomed with the training and technical skills required for job expertise. In the current age of digital innovation, the 10 Minute School is leveraging the power of e-learning to deliver academics, knowledge, and skill-development materials to youths of all socioeconomic backgrounds. This mEeducation platform is acting as a great enabler of developing human capital resources to catalyze a fast-evolving digital economy. The 10 Minute School is equipping the youth with specific job skills and providing higher freelancing opportunities to add to the existing base of 550,000 registered freelancers.

## Weaknesses

### 1. Lack of IP Rights

While Bangladesh has the required laws to protect intellectual property rights (IPR), there is an absence of effective protection of IPRs at the national level, leading to a dearth in the development, transfer, and trade of knowledge-based goods and subsequent technology-based development. Inadequate legal protection concerning the misappropriation of IPRs through free riding of internationally known trademarks is common in Bangladesh. This leads to a decline in foreign direct investment (FDI) and technology transfer. The absence of effective protection and enforcement of IPR is also incompatible with the international obligations of Bangladesh and prevents Bangladesh from benefitting from the global multilateral trading regime. While Bangladesh has slowly made progress in bringing its legislative framework into compliance with the WTO Agreement on Trade-

Related Aspects of Intellectual Property Rights (TRIPS), a draft act prepared in compliance with the TRIPS agreement requirements in 2014 remains under ministerial review and has not made any measurable progress. In the absence of adequate legal protection of IPRs, and no IPR enforcement division within the government, markets are being distorted, consumers are being misled, and foreign investment is being deflected.

## 2. Software Piracy

As per Bangladesh law, software piracy is illegal. But this has not prevented Bangladesh from having one of the highest software-piracy rates in the world and the highest rate in the Asia-Pacific, amounting to 84 percent. There prevails a widespread lack of government enforcement toward prevention of software piracy. This high piracy rate hinders economic growth and increases exposure to malware risks. It also affects the IT development of the nation. Software manufacturers are affected and may suffer losses and become demotivated with the launch of a new software. Software piracy also brings to light the issue of other types of pirated content such as music, videos, and books into the discussion of intellectual property. Computer users in Bangladesh and especially businesses using unlicensed software are becoming increasingly vulnerable to the possibility of cyber-attacks and restrained revenue growth. Foreign investment in the country is being hampered due to the prevalence of piracy and misuse of available technology for stealing software.

## 3. Non-conducive Business Ecosystem

Bangladesh has ranked 177 out of 190 in the World Bank's annual Ease of Doing Business Index. The reasons cited by World Bank for the consistent, consecutive low rankings since 2014 include the growing cost of opening a business, complicated tax-return procedures, bureaucratic red tape, and other significant bottlenecks. This is affecting Bangladesh's global image as a foreign investment frontier. The inadequate structure of the basic ecosystem is impeding foreign investment, with Bangladesh's total direct foreign investment accruing to nearly $3.0 billion USD in FY 2017–2018, falling short of the foreign investments made in neighboring economies such as Myanmar and Vietnam, which received foreign investments of $5.7 billion and $35.9 billion respectively. In addition, the domestic start-up ecosystem in Bangladesh has not yet developed into the more complex symbiotic inter-web that fosters innovation and transformation. Banks are reluctant to invest in venture capital funds for start-ups as the ecosystem is still being developed and is currently at a nascent stage. The number of potential and serious start-ups is limited due to the lack of experienced mentors and angel investors. Bangladesh also faces a shortage of locally developed incubators and accelerator programs essential for a mature start-up ecosystem. In mature economies, start-ups are backed by the innovative thinking of universities acting as knowledge centers, which is absent in Bangladesh. Instead of trying to tackle all these challenges itself, Bangladesh's government should focus on getting the policy environment right to support entrepreneurship and innovation and rely more on private sector and university participation, respectively, in attracting risk capital and supporting incubators and accelerator programs that can facilitate entrepreneurial activity. There also prevails a lack of updated, contextual data relating to demand, supply, and competition existing in the market. Accurate and relevant data, if provided, could create the foundation for successful entrepreneurship.

# Canada

*By: Richard C. Owens, Macdonald-Laurier Institute, Daniel Schwanen, C.D. Howe Institute, and Stephen Ezell, Information Technology and Innovation Foundation*

| Comparative Strengths | Comparative Weaknesses |
|---|---|
| 1. Innovative Tax Policies to Support Innovation<br>2. The Industrial Research Assistance Program and Its Provision of Industrial Grants for Innovation<br>3. Support for Emerging ICT Applications Such as Artificial Intelligence and Quantum Computing | 1. Intellectual Property Policy<br>2. Establishing a Supportive Environment for Life-Sciences Innovation<br>3. Adequately Focusing Policy on Bolstering Productivity |

## Strengths

### 1. Innovative Tax Policies to Support Innovation

To support business research and development (R&D) activity, Canada relies on a combination of direct funding (such as grants and procurement contracts) and tax relief. Federal R&D tax relief in Canada accounts for 85 percent of total public support for business R&D, which is the third-highest share among Organization for Economic Cooperation and Development (OECD) countries.[19] Canada's main instrument here is the federal Scientific Research and Experimental Development tax credit, which provides a 20 percent credit with a 10-year-carry-forward option for large enterprises, and an enhanced refundable tax credit of 35 percent (up to CAD 2 million) for small and medium-sized Canadian Controlled Private Corporations.[20] Between 2000 and 2013, the importance of R&D tax relief remained fairly stable in Canada, in both absolute and relative terms, and a recent OECD study found that Canada offers a more significant tax subsidy for small and medium-sized enterprises (SMEs) than do most other OECD nations, on average.

One laudable feature of Canadian tax policy in support of innovation is some provinces' use of innovative approaches. For instance, under Quebec's patent box mechanism, as Finn Poschmann of the Atlantic Provinces Economic Council described in a commentary article for *The Globe and Mail:*

> A Quebec manufacturing and processing firm calculates the share of its income derived from patents embodied in the products it sells. The share is determined by how much the firm spent in Quebec on research and development, including labour, in developing or acquiring the patents. In the case of an acquired patent, the underlying R&D must have been done in Quebec. A qualifying patent does not have to have been granted, but applied for in any competent jurisdiction. If not granted within a few years, the deduction is clawed back. Other measures restrain the size of the patent box, making the qualifying income easier

> to calculate. The underlying activity must qualify for the R&D tax credit, and a provision requires that the business has more than [CAD] 15-million in paid-up capital. That means that small businesses, already at the 4-per-cent tax rate, can't use the patent box to take their rate to zero. And the measure affects only income derived from patents applied for after March 17, 2016.[21]

Quebec has originated some of Canada's more innovative innovation policies. It's the first, and so far the only, province to try the patent box approach in Canada. It cleverly leverages Canada's well-tested Scientific Research and Development Tax Credit system both for economic advantage and to maintain the integrity of the research submissions. Similarly, Quebec is one of two Canadian provinces, along with Ontario, that offers collaborative R&D tax credits. For instance, firms in Ontario receive a 55-percent combined state-federal tax credit when they fund R&D projects undertaken in collaboration with a Canadian university or national laboratory.[22] However, while representing steps in the right direction, Canadian innovation policy still has to get more focused on supporting the growth of innovative firms.

## 2. The Industrial Research Assistance Program and Its Provision of Industrial Grants for Innovation

The National Research Council of Canada's Industrial Research Assistance Program (NRC IRAP) is Canada's leading innovation assistance program for small and medium-sized businesses. It helps innovative SMEs in Canada build innovation capacity and take ideas to market. It does this through financial assistance, advisory services, and connections to the best business and R&D expertise in Canada. It's a model Canada has used to drive business growth for over 70 years, and represents an extensive, tried-and-true program that leverages technology capabilities and infrastructure native to the federal government to nurture local projects.

IRAP works with both manufacturing and high-tech services SMEs, serving approximately 11,000 SMEs annually with CAD 290 million in FY 15–16 funding.[23] IRAP delivers its services through a network of over 250 Industrial Technology Advisors (ITAs) located across five regions—Atlantic & Nunavut, Quebec, Ontario, Prairies, and Pacific—and based in technology communities, local associations, universities, and colleges across the country.[24] IRAP's ITAs focus primarily on assisting Canadian SMEs with technology development, innovation, and new product development activities (as opposed to mostly lean manufacturing principles, although they do that as well) and play a special role in connecting technologies and knowledge emerging from Canadian universities and national laboratories with SMEs.

A 2016–2017 evaluation of the IRAP program by KMPG confirmed that IRAP delivers positive results for Canada's economy.[25] The evaluation estimated IRAP delivered economic benefits at least CAD 10 billion above the cost of the program from 2005–2006 and through 2015–2016. The ratio of IRAP's economic benefits to the cost of the program during this period was at least 4.9:1.[26] Likewise, a 2012 IRAP client survey found that 90 percent of IRAP clients reported enhanced technical knowledge or capabilities, while 82 percent reported an increase in scientific and technical knowledge. Seventy percent reported an increase in the firm's business skills and knowledge, and 62 percent reported an enhanced ability to perform R&D.[27] The evaluation further found that IRAP funding provided firms with the means to undertake innovation projects that otherwise would not have proceeded or would have been significantly downsized in the absence of IRAP funding.

### 3. Support for Emerging ICT Applications Such as Artificial Intelligence and Quantum Computing

Canadian innovation policy has played an important role in spurring Canadian industrial leadership in emerging information and communications technologies such as artificial intelligence (AI) and quantum computing. For instance, the Canada Institute for Advanced Research (CIFAR) is a global charitable organization that convenes extraordinary minds to address science's and humanity's most important questions. CIFAR invests primarily in faculty, university research, and networking—where government engagement can be most effective. CIFAR plays a significant role in AI research in Canada and around the world. It helped to enable some of the fundamental breakthroughs in the field through its Learning in Machines & Brains program, which continues to deliver groundbreaking research. It leads a CAD 125 million national strategy to establish Canada's international leadership in AI. It also runs a program that explores the ways AI will reshape society. CIFAR announced the first cohort of researchers to the Canada CIFAR Artificial Intelligence Chairs program, a CAD 30 million investment.

Canada has emerged as a leader in quantum computing, with quantum computing clusters emerging in the vicinity of both Vancouver and Waterloo. For instance, D-Wave Technology, from Vancouver, has developed a 10-foot-tall, 2,000-qubit quantum computer, which retails for $15 million and is purpose-built to run algorithms that solve specific types of optimization problems, such as identifying optimal transportation routes, trading strategies, and supply-chain management solutions.[28] In 2015, Canada's federal government invested CAD 15 million to support the country's development of a quantum computing sector.[29] The resources funded the strategic plan of the University of Waterloo-based Institute of Quantum Computing to carry out and commercialize research into quantum technologies. *The Economist* estimated that Canada's annual investment in non-classified quantum computing research has grown to over €100 million annually.[30] A 2019 analysis estimated that the Ontario and Canadian governments have invested over $1 billion combined over the last decade in quantum computing.[31] This robust government investment, combined with a $100 million venture fund for technologies that employ practical applications of quantum physics, started by Mike Lazaridis and Doug Fregin (who together founded BlackBerry), has given rise to what's now called Canada's "Quantum Valley," a fertile region for quantum computing innovation centered around Waterloo, Canada.[32]

## Weaknesses

### 1. Intellectual Property Policy

On April 27, 2018, the Canadian government launched a new IP Strategy, promising to invest CAD 85.3 million ($66.5 million) over the ensuing five years to bolster IP legislation, tools, and education.[33] Canada's IP Strategy is supposed to help give businesses the information and confidence they need to grow and take risks. It will make changes in three key areas:

*Legislation*

- The IP Strategy will amend key IP laws to remove barriers to innovation, particularly loopholes that allow those seeking to use IP in bad faith to stall innovation for their own gain.
- The IP Strategy will create an independent body to oversee patent and trademark agents, which will ensure professional and ethical standards are maintained, and will support the provision of quality advice from IP professionals.

*Literacy and Advice*

- As part of the IP Strategy, the Canadian Intellectual Property Office will launch a suite of programs to help improve IP literacy among Canadians.[34]
- The IP Strategy includes support for domestic and international engagement between Indigenous people and decision-makers, as well as for research activities and capacity building.
- The IP Strategy will also support training for federal employees who deal with IP governance.

*Tools*

- The IP Strategy will provide tools to support Canadian businesses as they learn about IP and pursue their own IP strategies.[35]
- The government is creating a patent collective to bring together businesses to facilitate better IP outcomes for members. The patent collective will be the coming together of firms to share in IP expertise and strategy, including gaining access to a larger collection of patents and IP.

While Canada's approach is innovative to some degree, this has a lot do with the issue that government really should not be doing these things. Some of the goals are just unobtainable: How will government advisers really coach entrepreneurs to innovate? How will a patent collective actually work? And what does it have to do with indigenous policy? In other words, real IP strategy involves strengthening IP rights, and that's where the Canadian government's IP strategy should have been focused first and foremost.[36]

## 2. Establishing a Supportive Environment for Life-Sciences Innovation

From 2009 to 2015, Canadian life-sciences R&D investment by large, patent-holding pharmaceutical companies declined by 34 percent, from $1.32 billion in 2007 to $869.1 million in 2015. The Canadian pharmaceutical sector's share of total manufacturing R&D fell to 6.9 percent in 2015 (a share less than half the level in 2002), and just 40 percent of the industry's share of R&D in the United States. Canada's biopharmaceutical industry remains quite small: smaller than Sweden's, even though Canada's economy is more than three times larger. The sector's sagging R&D investment is indicative of the fact that, from 2001 to 2014, Canada's national R&D intensity (total R&D investment as a share of gross domestic product) fell by over 20 percent, from 2 percent in 2001 to 1.6 percent in 2014. That actually widened the gap between Canada and peer nations, as average R&D intensity in OECD countries increased from 2.13 percent to 2.37 percent over that time span.

But beyond sagging R&D investment, the leading reasons why Canada has struggled to support a vibrant life-sciences industry pertains to historically weak intellectual property policies (as the prior weakness alluded to) and a drug pricing system that doesn't permit innovators to earn returns that can be invested in future generations of innovation.

Canadian life-sciences innovation was particularly stifled from 2005 to 2017, by Canadian courts' use of the so-called Promise Doctrine, an impractical evidentiary burden not used anywhere else in the world, which effectively required pharmaceutical innovators to predict at the date of filing—in many cases before R&D and clinical trials had even been completed—specifically how useful a patented drug would be in the future. Under the Promise Doctrine, if any one of the initial claims (i.e., "promises") in the patent application went unrealized, patent applications could be revoked in their entirety. Canada's discriminatory application of the Promise Doctrine led to

29 court decisions that invalidated 26 patents on 22 medicines over the past decade, leading pharmaceutical companies to suffer well over $1.1 billion in lost sales.[37] Fortunately, the Canadian Supreme Court invalidated this approach in a June 2017 decision in *AstraZeneca Canada Inc. et al. v. Apotex Inc.,* with the Court ruling 9 to 0 that the deprivation of patent protection because not every promised use was sufficiently demonstrated or soundly predicated at the date of filing was "antagonistic to the bargain on which patent law is based wherein we ask inventors to give fulsome disclosure in exchange for a limited monopoly."

Both the C.D. Howe Institute and Macdonald-Laurier Institute have pointed out that strict drug price controls in Canada have precluded the realization of profits that are important for innovation. As the C.D. Howe Institute observed in its report, "High Drug Prices, Big R&D Spenders" and "Free Riders: Canada in the Topsy Turvy World of Pharmaceuticals," countries such as Canada both want the best drugs available to treat illnesses—some that can only or best be treated with very innovative drugs—but face severe budget constraints due in part to an aging population, which leads them to formally control drug prices or otherwise seek to lower the cost of medicines, which in turn can have a deleterious impact on innovation and the availability of innovative products in Canada.[38] Essentially, Canada wants innovative drugs, but doesn't want to pay as much as others for them. The C.D. Howe Institute report suggests this could be addressed by adopting international mechanisms that might see rich countries such as Canada shoulder more of the cost burden of supporting pharmaceutical innovation.

### 3. Adequately Focusing Policy on Bolstering Productivity

At the start of 2019, Canada's GDP per person employed was 73 percent of the U.S. level.[39] The real explanation for this gap lies on the yawning productivity gap between Canada and the United States. Between 1996 and 2015, U.S. average annual value added per worker growth in advanced industries averaged 3.2 percent per year, while Canadian productivity growth in these industries averaged 0.3 percent.[40] Part of the challenge is small firm size in Canada, where productivity in plants with 100 or fewer employees was 62 percent of the industry average, but 165 percent in plants with 500 or more employees.[41] The smaller average firm size in Canada accounts for approximately 20 percent of the gap in Canada-U.S. sales per employee, and 48 percent in manufacturing. These figures suggest Canadian policy needs to get more focused on increasing productivity and bolstering firm size. One way it could help achieve this is by removing regulatory barriers that inhibit interstate trade and competition in Canada.

### Jury Still Out

In March 2017, the Canadian government announced a "superclusters" initiative that promises to invest CAD 950 million (€655.5 million) over five years to develop superclusters in seven key national industries: 1) advanced manufacturing; 2) agri-food; 3) clean technology; 4) digital industries; 5) health and bio-sciences; 6) clean resources; and 7) infrastructure and transportation.[42] It's anticipated the investment will be matched dollar for dollar by the private sector, with the plan expected to create more than 50,000 jobs over ten years and grow Canada's GDP. As part of the plan, the Government of Canada challenged Canadian businesses of all sizes to collaborate with other innovation actors, including postsecondary and research institutions, to propose bold and ambitious strategies that will transform regional innovation ecosystems and develop job-creating superclusters of innovation, such as Silicon Valley. While the superclusters approach shows initiative and holds promise, it's too early to declare definitive results, but the program does deserve mention as a key component of Canada's innovation strategy.

# Chile

*By: Natalia Gonzalez, Libertad y Desarrollo*

| Comparative Strengths | Comparative Weaknesses |
|---|---|
| 1. Chilean State Modernization<br>2. New National Office of Productivity and Entrepreneurship<br>3. Better Policy and Regulatory Environment for Starting Up Businesses and Addressing Insolvency and Bankruptcy | 1. Promoting and Training Advanced Human Capital<br>2. Private Investment in I+D<br>3. Chilean State Data/Information |

## Strengths

### 1. Chilean State Modernization

The Chilean government is decidedly promoting efficiency in public administration and in the provision of public services to Chilean citizens. In this regard, it has supported the creation of a permanent modernization of the State Counsel, integrated by well-renown professionals, that will permanently advise the Chilean government. Likewise, through the Digital Government Division of the Office of the Secretary General of the Presidency and a permanent cross-ministries committee, it is constantly providing advice and support to public institutions in the smart design and redesign of public services, and in the process of digital transformation of the relevant institutions and their processes. The former, through advanced technological solutions and institutional innovation, are leading cross projects to implement strong-quality public services. In the legislative arena, the Chilean government has presented for discussion to its National Congress a bill that addresses the digital transformation of the Chilean state, seeking to implement, through electronic procedures, a simplification of the relevant processes involved. The Chilean government is also promoting a bill in Congress that includes several improvements to its current legislation regarding access to public (state) information and transparency, which constitutes a valuable effort.

### 2. New National Office of Productivity and Entrepreneurship

The Chilean government has implemented a new National Office of Productivity and Entrepreneurship (OPEN), in order to simplify the due diligence that must be performed by the private sector under the regulatory authority of a public entity or service and reduce bureaucracy in order to boost productivity and economic activity, as well as to assist micro-, small-, and medium-sized companies in their integration to the modern global economy, thus promoting innovation. The goal is to duplicate the ability of Chile's economy to grow, invest, and create jobs, along with creating new business and promoting new entrepreneurs. In line with the aforementioned, the Chilean government has presented a bill to Congress with 20 concrete initiatives to reduce bureaucracy and simplify the regulatory burden, including the legal recognition of this office, so that it becomes a

permanent organization, with a well-defined role and levels of autonomy. This office is also meant to evaluate and continually improve regulations that may have an impact on productivity and competitiveness, in line with the recommendations of the Organization for Economic Cooperation and Development (OECD) in 2016, as contained in the document entitled "Regulatory Policy in Chile," seeking to simplify and harmonize the relevant regulations and improve their efficacy, predictability, compliance, and supervision.

### 3. Better Policy and Regulatory Environment for Starting Up Businesses and Addressing Insolvency and Bankruptcy

Chile has implemented reforms, making it easier for entrepreneurs to start up a business—including removing regulatory barriers of entry and reducing procedures, time involved, and bureaucracy—or to close a failed one. Currently Chileans can open a business in only one day, and there are more financing opportunities and public/state programs, through Corporación de Fomento de la Producción (CORFO), that have fostered and increased the interest of the financial sector to fund the relevant projects. Likewise, and following recommendations by the International Monetary Fund and OECD, the current government is gradually abandoning the "cluster-based" or "strategic-investment based" industrial policy, and moving toward implementing horizontal instruments and facilitating the strategic coordination of different sectors and institutions so that they determine the areas which will be necessary to advance in order to further develop and diversify Chile's economy. Finally, recent new legislation regarding insolvency and bankruptcy regimes is more efficient, making it easier for entrepreneurs to stand up again, by reducing costs, procedures, and the periods of time involved in the closure of a certain business, among others.

## Weaknesses

Although the *Global Innovation Index 2018* positions Chile as the best ecosystem for innovation in Latin America, ranking it among the 50-best economies in this regard as to its institutions, generation of technology, knowledge, and business sophistication, there is still much catch-up to achieve. Chile exhibits deficiencies in the quality of its education system, efforts in innovation and research and development (I+D), and scientific production.

### 1. Human Capital: Chile Needs to Promote and Implement Public Policies Oriented to Boost Advanced Human Capital

As for the labor force, Chile needs to improve the current national system (and programs) of continuing education and ongoing labor training to meet the needs of an advanced economy of the future and those of the productive sectors. This includes the necessary transition and adaptation of the labor force to the new technologies and the new labor dynamics and markets, creating bridges between the business sector and scientific, academic, and technological institutions that will meet the needs of the first, as well as efforts to diminish the current deficit of technical professionals. The aim is to facilitate, through these programs, the technological revolution, increase knowledge, abilities, and skills to improve access to new job positions, upsurge the labor participation of certain groups (especially women and youth), and enable labor re-organization and modernization, which should drive broader Chilean productivity growth. Current national labor training programs are too rigid; construed under criteria or goals that are obsolete; too standard and somehow superficial, and don't promote abilities consistent with the changing industrial needs. Quality controls of such programs, as to the fulfilment of their objectives, are also deficient. The regulation in connection with such programs should be reformulated so as to adapt to the needs of the different productive

sectors and groups of employees, creating latest-generation technological abilities. Likewise, labor-training programs concerning the public sector labor force should be rationalized.

In this regard, Chile's educational system is also in debt. The reforms adopted in connection with its education system, in recent years, have not addressed the quality of the same, in all its stages, and have overlooked excellence in early, preparatory, high, and technical education, as well as the necessary modernization of the curriculum, incorporating critical thinking and new skills as well as new technologies. Chile should also seriously consider focalizing the existing advanced human capital available in the country. Becas Chile (the largest national scholarship program) is actually reviewing its goals and processes to redirect efforts since many of the doctorates and Ph.D.'s that return to the country are having trouble finding attractive job positions.

## 2. Private Investment in Research and Development

[Note, Chile refers to this as Innovation and Research and Development, or (I+D)]. Chile needs to promote the use of science and technology to develop new products, designs, processes, and business models, as well as innovation and private investment in I+D, fostering common projects between the university/knowledge centers and the private and public sector. Investment in I+D should constitute one of the fundamental cores in order to allow more innovation and to improve efficiency in productive processes. Chile not only invests very little in I+D, it also registers one of the lowest indexes of OECD nations in terms of collaboration between the productive private sector and academic organizations. On average (as a proportion of GDP), OECD countries exhibit a 2.4 percent investment in I+D, while in Chile it comes to only 0.4 percent. Also, compared with other OECD countries, private sector investment in Chile in I+D is one-third, although the remaining two-thirds come from Chilean state participation in such investment. On average, the situation of the remaining OECD countries is the opposite.

Chile has important legislation in place that establishes a tax incentive for private sector companies investing in I+D. This legislation was reviewed in 2010–2012, in order to amplify its scope and make the tax stimulus more flexible.[43] Administrative measures were also adopted to reduce associated bureaucracy and simplify the processes involved. Notwithstanding those positive changes, still further efforts could be made to continue to simplify procedures and extend the tax benefit or make it applicable against other taxes, not only the corporate tax. It has been recently announced by the Chilean government that they are studying a reform to the relevant legislation in order to boost the investment in I+D in small- and medium-sized companies, but details are yet unknown.

The recently created and implemented Ministry of Science, Technology, and Innovation in Chile should also play a role in this area, acting as an articulator and promotor of the connection and coordination between the academic and scientific worlds and the private productive sector so that academic and scientific innovation may have productive uses, amending coordination deficiencies. Chile has a unique offer in the region in this sense, with 12 "Centros de Excelencia"—knowledge centers that comply with the highest international standards—that work in alliance with Chilean centers, allowing that basic and advanced investigation, in diverse sectors, may be translated into concrete innovation, recognized and valued by the market, with commercial perspectives.

## 3. Public Data

The Chilean government administers a wide and increasing volume of information. However, the administration of such data doesn't currently have a strategic and coherent procedural orientation.

Databases are fragmented or construed manually for specific purposes, and in many occasions contain error or inconsistencies. Public registries or datasets so generated are rarely integrated, which doesn't allow for a correct evaluation and monitoring of the relevant governmental programs and public policies involved.

The Chilean government is making an effort toward digitalizing and modernizing its procedures and designs, which is valuable and on the correct path. Such effort should include an integral attempt—as there are currently in place isolated initiatives that are certainly valuable—to have a comprehensive and coherent strategy to facilitate information flow within government organizations and public services, facilitating interoperability and permitting the elaboration of better diagnoses and public policy evaluations based on data.

# China

*By: Caleb Foote and Stephen Ezell,*
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| Comparative Strengths | Comparative Weaknesses |
|---|---|
| 1. High Levels of R&D Investment<br>2. Educational Reforms Promote a Skilled Workforce<br>3. A Comprehensive Innovation Framework | 1. Incentive Structures Don't Necessarily Maximize Outputs From Innovation Inputs<br>2. Sheltered Markets Shield Companies From Best-in-Class Competitors<br>3. Weak Intellectual Property Rights Protections Despite Recent Improvements |

## Strengths

### 1. High Levels of R&D Investment

China's investment in research and development (R&D) has grown dramatically over the past decade, increasing at an annual rate of 13.1 percent from 2007 to 2017, to a total of $496 billion, as highlighted in ITIF's report "Is China Catching Up to the United States in Innovation?" In fact, China has likely surpassed the United States in investment in the later stage (i.e., applied) R&D that turns discoveries into commercial products. A 2017 Boston Consulting report, "An Innovation-Led Boost for U.S. Innovation," estimated that in 2018 China would invest up to twice as much as the United States—$658 billion versus $312 billion—on this critical late-stage research (based on investment trends from preceding years). The Chinese government has facilitated this growth in R&D investment both directly, more than tripling its research investments from 2007 to 2017 (reaching $98 billion in 2017), and indirectly, such as by establishing high-tech zones and science parks, and by providing tax incentives for innovation activities. For instance, China's patent box system, which provides tax breaks for revenues earned as a result of a firm's patents, is particularly expansive, giving a favorable tax rate to firms that invest at least 3 to 6 percent of gross revenue in R&D, generate 60 percent of their revenue from intellectual property (IP), or have a substantial percentage of skilled workers or high-tech occupations. China's patent box system effectively lowers the tax rate on qualifying R&D to between 0 and 12.5 percent.

While this report generally focuses on innovation policy rather than performance, it is clear these policies have had a robust impact on driving the growth of China's innovation-based industries. According to the U.S. National Science Board's *2018 Science and Engineering Indicators* report, China's share of global output of high-technology manufacturing industries increased from 8 percent in 2003 to 27 percent in 2018 (just 2 percentage points lower than the U.S. share that year). Reflecting this, China has become the largest global producer in information and communications technology (ICT) manufacturing industries, with a 40 percent share, and is now the largest global

producer of pharmaceuticals. And China now accounts for two-thirds of the world's production of solar panels. Moreover, it's not that China is just producing low-value-added goods, a recent University of Sussex study found the average value China adds to its exports is 76 percent (for comparison, the European Union's share is 87 percent).

## 2. Educational Reforms Promote a Skilled Workforce

Until recently, education lagged behind R&D investment among the Chinese government's priorities. However, the release of the National Medium- and Long-Term Plan for Education Reform and Development in 2010 marked a shift toward a focus on education, which is emphasized in China's 13th Five-Year Plan (2016–2020). This will help Chinese universities continue to improve in quality, complementing the dramatic increases in the number of Chinese graduates that have already been witnessed. More than 3.4 million Chinese students earned their first degree in 2014, up from 1.2 million in 2004, 48 percent of which were in science and engineering (S&E), compared with 39 percent in the United States. Further, as the U.S. National Science Board's *2018 Science and Engineering Indicators* report noted, China has more than quadrupled the number of S&E degrees conferred since 2000, which now accounts for nearly half of all bachelor's degrees awarded in China. Overall, the number of S&E bachelor's degrees in China increased from 359,000 in 2000 to 1.65 million in 2014. That report further found that, while the United States remains the world leader in the production of S&E doctoral degrees, awarding 40,000 in 2014, China has closed the gap with the United States markedly, producing 34,000 doctoral degrees in 2014, compared with the only 8,000 it produced in 2000. The report further noted that in 2007 China surpassed the United States as the largest producer of doctoral degrees in natural sciences and engineering, and has held the lead in those fields ever since. These graduates will form the backbone of a skilled Chinese workforce that is capable of innovative activities—and can capitalize on them.

## 3. A Comprehensive Innovation Framework

China excels in directing resources toward cutting-edge industries and coordinating action across levels of government, allowing more efficient prioritization of the most promising areas for innovation. Most prominently, China's "Made in China 2025" strategy (released in 2015) represents a strategic plan for an innovation-based Chinese economy. The strategy identified 10 key industries in which China wishes to become a global leader by 2025, including information technology, robotics, and medicine and medical devices. As the U.S. Chamber of Commerce noted in its report "Made in China 2025," nearly 800 state-guided funds with a total value of RMB 2.2 trillion (over $300 billion) have been established to support various industries and initiatives associated with the Made in China 2025 strategy. Further, in 2015, the national government worked to normalize the practices of local governments, increasing disclosure requirements, facilitating business registration, and encouraging local governments to establish venture funds.

A number of other federal promulgations have been issued to support the innovation environment in China. In June 2015, the Chinese government issued a document called "Advice and Measures for Promoting Mass Entrepreneurship and Innovation," which supported local governments to set up venture funds, improved the policy of loan guarantees for entrepreneurs, and eased business-registration procedures. In August of that same year, China passed the Law of the People's Republic of China on Promoting the Transformation of Scientific and Technological Achievements (2015 Amendments), which provided for the independent transfer of research achievements and more transfer income to research teams, and encouraged intermediaries to accelerate the transformation process. And in August 2016, China issued the 13th Five-Year Plan for National Science and

Technology Innovation, whose goals include strengthening original innovation, optimizing regional innovation layout, and building high-skilled talent.

## Weaknesses

### 1. Incentive Structures Don't Necessarily Maximize Outputs From Innovation Inputs

Over 426,000 peer-reviewed science and engineering articles were published in 2016 by Chinese authors, more than double the 190,000 a decade prior. But much of that growth has been of questionable quality. Publications are the primary metric by which individuals and institutions are evaluated, with some scientists being directly paid for each article they publish leading to a significant incentive to shift from novel work to whatever can be published most quickly—and even raising concerns of plagiarism and fabricated data. While Chinese articles and patents have been cited more frequently in recent years, in line with the global average, this too may be misleading, as 72 percent of the growth in Chinese patent citations has been driven by authors citing their own patents, which they do more than three times more than authors from other nations. Until the Chinese government accounts for these behaviors, and incentivizes innovative and impactful research, large swaths of China's R&D investments will continue to be wasted.

### 2. Sheltered Markets Shield Companies From Best-in-Class Competitors

Chinese firms face dual disincentives to engaging in innovation stemming from the government's control. First, state-owned enterprises lack robust profit incentives to increase performance due to formal and informal protections to their budgets and markets, leading them to have lower rates of R&D productivity than private firms in China. Second, too often, China limits access to its markets for foreign firms in key industries. This has enabled the growth of domestic firms in sheltered Chinese markets. On one hand, that has enabled Chinese companies in advanced-technology sectors to achieve economies of scale they can they use to lower their cost base and more effectively compete in global markets; on the other hand, it shields them from best-in-class competitors, thereby weakening their incentives to innovate, and making them more vulnerable as they "go out" into global markets. In Japan, that dynamic was identified as the "Galapagos Island Syndrome": Highly competitive advanced technology companies in domestic markets encountered extreme difficulty when they tried to compete in international technology marketplaces. A manifestation of this, as ITIF wrote in its report, "The Middle Kingdom Galapagos Island Syndrome: The Cul-De-Sac of Chinese Technology Standards," is that Chinese attempts to promulgate domestic information technology standards may ill-position Chinese tech companies that wish to compete in international markets. Chinese firms, and the international innovation economy as a whole, would benefit if all enterprises had to face international competitors on fully market-based terms.

### 3. Weak Intellectual Property Rights Protections Despite Recent Improvements

While China has made recent attempts to improve its IP environment, it still has a considerable way to go. One in five North American-based corporations report that Chinese companies have stolen their IP within the last year, according to a 2019 report by the CNBC Global CFO Council. China remains relatively weak in terms of trade-secret and copyright and trademark protections, and enforcement thereof. China ranked 25th out of 50 nations in the U.S. Chamber of Commerce's *2019 Global IP Index*, which lauded China's "strong efforts to raise awareness and leverage the value of IP rights in academic and private spheres," but faulted China for maintaining "significant

barriers to technology transfer, market access, licensing, and the effective commercialization of IP," and for "direct government intervention in licensing agreements and requirements of technology transfer as a basis for market access." The life-sciences sector provides a nice example of this dichotomy. China is implementing a stronger pharmaceutical patent enforcement regime through a new patent linkage mechanism for biopharmaceuticals. Further, the Chinese government has said it will lengthen patent protection on pharmaceuticals from 20 to 25 years. Further, China provides only a 6-year data-exclusivity period for drugs that contain new chemical entities, compared with 12 years in the United States; however, the Chinese government has said it will increase that period to 10 to 12 years for new therapeutic biologics, and 6 years each for new small molecule drugs, orphan drugs, and pediatric drugs (although apparently this will only apply to medicines first introduced in China).

All this matters because strengthening IP rights is crucial for innovation in China, with research showing a 7-percent increase in patenting in regions with stronger IP rights protections, while increasing the availability of loans for high-tech firms. However, it's not just about IP rights, but enforceable property rights generally. For instance, a 2012 study found that 43 percent of Chinese villages had land seized by the government, which was then sold at more than 40 times the level of compensation on average, despite regulations in 2011 banning the use of violence during seizures, and requiring market-rate compensation.

China should strengthen its IP rules because it would strengthen Chinese innovation. But more than that, China's membership in the World Trade Organization obliges it to afford national treatment, meaning it must provide the same rules and protections—including with regard to IP rights—to foreign firms as it provides to domestic ones.

# Colombia

*By TicTac*

| Comparative Strengths | Comparative Weaknesses |
|---|---|
| 1. Boosting Open Data and Interoperability<br>2. Improving Public Procurement and Access to Public Information<br>3. Promoting Internet Awareness | 1. Lacking ICT Infrastructure<br>2. Need to Digitalize Public Services<br>3. Too Much Software Piracy |

## Strengths

### 1. Boosting Open Data and Interoperability

Over the past few years, the Colombian government has managed to significantly increase the number of datasets on its Open Data Portal (www.datos.gov.co), and has also invested in increasing the accessibility of those datasets. The portal has more than 10,200 datasets from 1,184 public institutions available. All data published can be used by anyone in order to develop applications or value-added services, perform analysis and research, exercise control tasks, or perform any type of commercial or noncommercial activity.

Furthermore, in April 2018, Colombia became the first Latin American country to institute a public policy for data mining. This policy, called "CONPES 3920: Política Nacional de Explotación de Datos (Big Data)," aims to overcome the challenges that have prevented the accessibility to public databases through the encouragement of data-based supply and demand, as well as the definition of a legal framework and the distinction between different types of data. This policy sets out a roadmap for the country regarding the proper use of data and its benefits. This will contribute to the fulfillment of the Sustainable Development Goals (SDGs), especially those related to the development of innovation, promoting public access to information, and achieving a significant increase in reliable and high-quality data.

### 2. Improving Public Procurement and Access to Public Information

Transparency and efficiency have been improved through the creation and strengthening of a centralized public procurement agency, Colombia Compra Eficiente. This agency is in line with Organization for Economic Co-operation and Development (OECD) recommendations, which puts all tenders online, and provides a new, transparent framework for procurement.

In 2015, the platform SECOP II had 101 state institutions and 2,629 suppliers registered to it. By 2017, the platform had grown significantly, reaching 1,547 state institutions and 113,078 suppliers registered. Nowadays, additional efforts are underway to expand further regional deployment and constant use.

### 3. Promoting Internet Awareness

Colombian authorities and private institutions have developed different initiatives to ensure the responsible use of online technologies by children and adults. Digital campaigns such as "En TIC Confío" (In ICT I Trust) offer citizens tools that can help them raise Internet awareness and prevent the risks associated with the use of new technologies, such as sexting, phishing, cyberbullying, cyberdependence, and child seduction and pornography. To deal with cybercrime, Colombian police have developed an Observatory on Cybercrime (Cai Virtual), which generates alerts and analyses cybersecurity threats. The Observatory also diffuses good practices to the public. Improving awareness can produce safer and greater adoption of the Internet.

## Weaknesses

### 1. Lacking ICT Infrastructure

One of the biggest challenges Colombia has to face to ensure innovation policies work is the lack of ICT infrastructure. Currently, Colombia has around 18,000 hotspots for mobile connection and 20,000 km of optical fiber that connect 1,075 out of the 1,101 municipalities in the country. However, it's estimated that 17 percent of all mobile phones (10 million devices), are connected to mere 2G networks, especially in rural areas.

In order to overcome administrative barriers, especially in municipalities, the state has included the promotion of IT infrastructure development in its National Development Plans (PND) since 2011. The "*Vive Digital"* plan became the catalyst for development in Colombia's ICT sector. It improved connectivity through the deployment of a national optical fiber network and, with its second phase (2014–2018), managed to improve human capabilities to develop ICT applications. In April 2019, through the approval of the new PND, the government decided the Ministry for Information and Communications Technology would be granted the authority to prioritize the development of ICT infrastructure in certain municipalities, according to their needs.

### 2. Need to Digitalize Public Services

Over the past few years, the digital strategy of the Colombian government has focused its efforts on four areas: (1) ensuring citizens have high-quality online services; (2) promoting empowerment and collaboration between citizens and the government; (3) finding different ways in which public institutions can optimize their internal management by using technology; and (4) guaranteeing the security and privacy of information. Different initiatives have been created in order to minimize bureaucratic procedures as much as possible. *Ventanilla Única* and *Carpeta Ciudadana* are two examples of this. Nevertheless, Colombia is stagnant. So far, only 18 percent of total government procedures can be completed online, and lack the needed traceability in order to be fully trustworthy.

### 3. Too Much Software Piracy

Using unlicensed software is not only illegal, but it also represents daily security risks. Despite the fact that the use of illegal software has decreased over the past few years, that reduction has been minimal. Thus, unlicensed software is still used in Colombia at an alarming rate, accounting for 48 percent of the total software installed on personal computers.

# European Union

*By: Stéphanie Lepczynski, Senior Director, The Lisbon Council*[44]

| Comparative Strengths | Comparative Weaknesses |
|---|---|
| 1. Setting Up Financial Instruments for Innovation<br>2. Supporting Digital Government<br>3. Agreeing on The Free Flow of Nonpersonal Data | 1. Completing the Digital Single Market<br>2. A Copyright Directive Fit for the Digital Era?<br>3. Europe 2020 R&D Target Is Fading Away |

The European Union (EU) is a very diverse entity from a demographic, cultural, and economic perspective. But innovation is typically a policy where the European added value is felt, as the scale of the EU allows for bigger projects to be funded, experiments to be run at higher scale, and standards to be applied over a larger territory. What has been successfully achieved in the European innovation policy, and what could be improved?[45]

## Strengths

### 1. Setting Up Financial Instruments for Innovation

In terms of innovation budget, the European Union puts its money where its mouth is. In the previous Multiannual Financial Frameworks, the research budget line had been increased by 30 percent (while there was extreme pressure on the account because of the aftermath of the financial crisis). Today, the main funding instruments directed to innovation are:

- Horizon 2020, the biggest EU research and innovation program for the period 2014–2020 with nearly €80 billion [$110 billion], including the European Innovation Council, which brings together funding opportunities for innovators;
- The European Fund for Strategic Investment (EFSI) and EFSI 2.0, the investment fund created in partnership with the European Investment Bank to fight the lack of confidence that resulted after the financial crisis; and
- VentureEU, the €2.1 billion [$2.6 billion] fund-of-funds program that backs venture capital in Europe.

One of the directorate general for research and innovation's missions is to "facilitate links between these funding programmes."[46]

### 2. Supporting Digital Government

In Europe, the public sector represents roughly half of the economy. Thus, ensuring that the public administrations are agile, citizen centric, and digital friendly is a key element in building an innovative economy and society.

However, digital government isn't an EU competence. A political commitment by the member states to shape a modern public sector was therefore needed. On October 6, 2017, all the European Union member states and European Free Trade Association (EFTA) countries signed the Ministerial Declaration on e-Government, also dubbed The 2017 Tallinn Declaration. Thereby, they reaffirmed their pledge to link up their public e-services and implement the eIDAS regulation and the once-only principle in order to provide efficient and secure digital public services that will make citizens' and businesses' lives easier.

By focusing on frameworks such as eIDAS, which allows for the mutual recognition of e-identities, and principles such as "once-only," which simplifies the procedures for citizens and businesses in their interactions with administration, the goal is to move from the simple delivery of online services (i.e., submitting forms to a public authority online) which is nice and already done by more than half of the EU population, but not as transformative as the idea of a government as a platform, where the government is a facilitator, a connector between the various actors, and enables them to perform their activities smoothly.[47]

### 3. Agreeing on the Free Flow of Nonpersonal Data

As the Lisbon Council has written, "Data is not oil, or currency, or infrastructure. Data is data. It plays a unique role, has unique characteristics and often follows an economic logic of its own," for which an optimal system needs to be defined if Europe wants to reap the benefits data is set to bring.[48]

Under the Estonia Presidency of the European Union, a compromise has been reached within the council to develop new rules to allow nonpersonal data to move freely and easily across country borders.

The negotiations culminated in June 2018 when the European Commission, the European Parliament, and the Council of the European Union reached a political agreement on one single principle across the EU: guaranteeing free flow of nonpersonal data. The principle consists in the removal of unjustified data-localization restrictions, the competence of regulatory and supervisory authority even when the data is processed across borders, security requirements on data storage, and single points of contacts within the member states.

## Weaknesses

### 1. Completing the Digital Single Market—Work in Progress

The Digital Single Market (DSM) strategy aims to improve access and establish fair conditions for citizens and businesses to operate effectively online and offline at home and within the entire EU. In particular, the strategy aims to build one, single big market for Europe's innovators, so that they can scale up and become economic champions. Despite the many policy measures taken to implement the DSM, the goal of creating one, unified market has not been reached yet. For example, only just over one-third of attempted cross-border purchases online are successful most of the time (37 percent) because of unjustified geo-blocking.[49] According to a DSM mid-term review analysis, the legislation is now in place, but Europe must move to "a mode where *adoption* of technology and *diffusion* of the most modern communication and manufacturing techniques [...] take centre stage" in order to reach the completion of the DSM.[50]

## 2. A Copyright Directive Fit for the Digital Era?

Europe and the United States have quibbled for years over the most-effective intellectual property regime in the digital age. The United States has a system based on "fair use," which was pioneered in the Digital Millennium Copyright Act (1998). In Europe, copyright "exceptions" are only granted based on a concrete list, which was last updated in 2001. Efforts to reform that list have led to a long and tedious effort to write new rules, which has been made more complicated by rights holders' efforts to extend and increase their rights rather than looking to make them sit more comfortably in the digital age. For example, Europeans have proposed the creation of a new "snippet tax," which would require that licenses be granted for the use of short text in search results. And a "right to panorama" would allow building owners to tax or charge Internet users if their property featured in a digital image used on the Internet somewhere, even as a background. After a dramatic set of events, the European Parliament approved a version of the new law in September 2018.[51] This version of the text includes, in particular, Article 11, the "snippet-tax" article, as well as Article 13, dubbed the "upload filter" clause, which requires Internet platforms to stop users who are uploading unlicensed work. A "remixing exception" for user-generated content (such as memes, GIFs, and libdubs) was voted down by the European Parliament. Supporters of the text say it will ensure fair remuneration of the artists for the content they create. Critics argue that the disbursement of these funds is not transparent and seldom benefits artists, adding that the Internet has been an excellent format for small artists to gain new audiences. Now, the dossier has entered *trilogue*—where the Council of the European Union, the European Commission, and the European Parliament negotiate a final text behind closed doors. As a next step, the European Parliament will be called on to vote again on the compromise in January 2019. It's difficult to predict what the compromise will look like, let alone how it will be implemented in the member states, but the stakes are high for the creative and innovative features of the Internet.

## 3. Europe 2020 R&D Target is Fading Away

Europe 2020 is the European strategy for growth and jobs for the current decade. It is structured around five pillars (employment, research and development, climate change and energy, education, poverty and social exclusion), where specific targets have been defined. In research and development (R&D), the goal is for member states to reach 3 percent of the EU's gross domestic product to be invested in R&D. But according to the latest review of the strategy by Eurostat, "For three consecutive years R&D expenditure in the EU has stagnated around 2.03 percent of GDP, further decreasing the chances that the EU will reach its 3 percent target."[52]

# Germany

*By: Axel Plünnecke, The German Economic Institute*

| Strengths | Weaknesses / Room for Improvement |
|---|---|
| 1. High Expenditures in Research and Development and Patent Activities<br>2. Vocational Training System<br>3. Strong Medium High-Tech Industries With Close Cooperation With Public Research | 1. No Research and Development Tax Deduction, Low Patenting Activities in Digitization<br>2. Lack of STEM Professionals<br>3. Lack of Start-Ups |

## Strengths

### 1. High Expenditures in Research and Development and Patent Activities

Germany's federal and state governments, as well as its companies, invest heavily in research and development (R&D). The expenditures in R&D as a percent of gross domestic product (GDP) and the European Patent Agency (EPA) patents per 100,000 workers are high, as table 1 shows. The automotive, engineering, and chemical industries are very strong in research and innovation.

**Table 1: European innovation indicators[53]**

| Country | Expenditures in R&D as % of GDP, 2016 | EPA Patents per 100,000 labor Force | EPA Patents in Digitization per 100,000 Workers |
|---|---|---|---|
| Sweden | 3.25 | 67.8 | 21.5 |
| Austria | 3.09 | 61.8 | 6.9 |
| Germany | 2.94 | 74.1 | 8.1 |
| Denmark | 2.87 | 59.5 | 3.2 |
| Finland | 2.75 | 55.8 | 19.6 |
| Belgium | 2.49 | 40.1 | 5.1 |
| France | 2.25 | 38.4 | 8.7 |
| Netherlands | 2.03 | 70.8 | 12.9 |
| Great Britain | 1.69 | 14.7 | 2.3 |
| Italy | 1.29 | 15.5 | 1.0 |
| Estonia | 1.28 | 6.0 | 1.4 |
| Spain | 1.19 | 6.3 | 0.7 |
| Ireland | 1.18 | 29.7 | 6.8 |

### 2. Vocational Training System

In Germany, employment of STEM professionals (both academic and vocational) are strongly linked to successful patent applications. Germany has a strong vocational training system.

The quality of an education and training system can best be judged by the results it produces for young people and companies across key success criteria. Roughly 7 million young Europeans between the ages of 15 and 25 are neither training nor working. Yet, the low levels of youth unemployment in countries with vocational training systems is striking: In 2017, Germany had the lowest youth unemployment rate of 7.2 percent (European Union average is 20.3 percent), followed by Austria (10.6 percent) and Denmark (10.8 percent)—all countries with vocational training systems.

### 3. Strong Medium High-Tech Industries With Close Cooperation With Public Research

Germany is highly effective in producing incremental innovations, thus improving existing products and gaining global leadership in specific market segments (so-called "hidden champions"). The research and innovation system supports this economic success by a close cooperation between large enterprises, the German *Mittelstand,* research institutions, and a strong education and training system. *Mittelstand* refers to the small and medium-sized enterprises (SMEs) in Germany that form the backbone of the country's economy. Numbering over one million companies, the *Mittelstand* employs over 20 million people, is responsible for almost 40 percent of total German gross investments, and accounts for 30 percent of its exports.[54] In Germany, there are strong networks between Fraunhofer Institutes, universities, and private research institutes providing frameworks for industrial partners.

## Weaknesses

### 1. No Research and Development Tax Deduction, Low Patenting Activities in Digitization

To achieve the government's goal of public and private R&D accounting for at least 3.5 percent of GDP (which was set in 2018), tax incentives for R&D activities should be introduced. Many countries provide such tax incentives, while Germany does not. Germany's plan for an R&D incentive may fall short of what is needed to boost investment in new technology.

Furthermore, the government should more strongly support research in digitization. Compared with other countries, Germany performs poorly in this field, with the number of EPA patents in digitization comparatively small.

### 2. Lack of STEM Professionals

To achieve the government's goal of investing 3.5 percent of its economic output in R&D, Germany would need a further 220,000 STEM employees with an academic degree or vocational training. Germany currently lacks more than 300,000 STEM employees—and if not for the high number of immigrants who have entered the country since 2012, it would be lacking another 200,000 STEM employees.

Immigration is making an ever-greater contribution to Germany's innovative strength. Measuring full patent equivalents, the proportion of inventors with foreign roots residing in Germany rose from 6.1 per cent in 2005 to 9.4 per cent in 2016.[55]

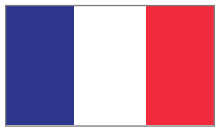
The planned Immigration Act, which aims to further simplify immigration procedures for technicians without an academic degree coming from third-world countries (an important group of potential inventors), would provide a positive impact to the German innovation system.

### 3. Lack of Start-Ups

Innovative start-ups are scarce, even though there are encouraging start-up clusters in a few leading cities, such as Munich and Berlin. But truly innovative start-ups with disruptive technologies that become global such as Google or Amazon are not being founded. Germany has a strong base of growing SMEs, but the number of companies being founded has been falling lately, and innovative start-ups are rare. Germany needs to establish a culture of entrepreneurship in universities to promote technology-oriented, knowledge-based spin-offs.

# France

*By: Sam SR, Information Technology and Innovation Foundation*



| Comparative Strengths | Comparative Weaknesses |
|---|---|
| 1. Grand Plan d'Investissement 2018–2022<br>2. Making AI a National Policy Priority<br>3. French Tech Visa for Foreign Digital Talents | 1. R&D Investment Has Stayed Flat Since 2015<br>2. Need to Improve Tax Incentives for R&D and Innovation<br>3. Stronger Relationship and Collaboration Between Public and Private Research |

## Strengths

### 1. Grand Plan d'Investissement 2018–2022

Under the Great Plan for Investment 2018–2022 (GPI), France plans for, "a total of €57 billion to sustain the greening of the economy, address skills mismatch, foster innovation and digitise public services." The plan allocates €9 billion for investing in low-income housing energy efficiency, €4 billion for transportation investment, and €7 billion for increasing renewable energy output, by a target of 70 percent.[56] GPI also seeks to help in training low-skilled workers and improving science, technology, engineering, and mathematics (STEM) education. France says GPI is funded through loans, new fiscal measures, and redirecting of existing investments, so the plan is stated to *not* increase the country's public deficit.

### 2. Making AI a National Policy Priority

France now has a national strategy for AI, titled "AI for Humanity," that projects €1.5 billion in investment from the public between 2018 and 2022.[57] One of the sub-priorities of AI in France will be coordination of a Health Data Hub. The Innovation and Industry Fund (Fonds pour l'innovation et l'industrie), which is partially funded through privatizations, will fund some of the AI development. This initiative relies on other, adjacent technologies and their own advancement, namely 5G. France announced last year its intention to create a "European DARPA" (Defense Advanced Research Projects Agency) through which €1.5 billion will be invested to support AI research and development.[58]

### 3. French Tech Visa for Foreign Digital Talents

Problems with the General Data Protection Regulations aside, starting March 1, 2019, France is implementing a "French Tech Visa" under which people seeking to create or work for a start-up in France, and their extended or immediate family members, can be granted a four-year visa to live and work in the country's tech sector.[59] It is unclear how powerful an effect this will have over the

incredibly strict regulations the tech sector is facing throughout the EU, but it's always good for innovation to reduce barriers to immigration for people who want to bring talent, investment, and ideas into an economy that is trying to grow. This is one small but important part of improving France's tech sector.

## Weaknesses

### 1. R&D Investment Has Stayed Flat Since 2015

Total R&D intensity has floated around the EU average the last few years, perhaps indicating some level of stagnation. Private-sector investment in R&D has risen, but has not yet reached the 2020 target of 3 percent of GDP. Policy solutions must be implemented in order to improve France's standing among other EU countries. Patent applications have been relatively flat as well over the last few decades.[60]

### 2. Need to Improve Tax Incentives for R&D and Innovation

France has an R&D tax credit system, the Crédit d'Impot Recherche, which was around 0.24 percent of GDP in 2018. But France isn't necessarily seeing significant-enough results from that and other investments. The *European Commission Directorate-General for Research & Innovation 2019* report states, "This warrants the need for a comprehensive evaluation of the policy mix to inform future implementation." There is a new body called the Innovation Council (Conseil de l'innovation), which began in July 2018, that will coordinate tax incentives at all levels of government in order to promote innovation.

### 3. Stronger Relationship and Collaboration Between Public and Private Research

France is significantly below the EU average with respect to privately funded, publicly conducted research and development. Only 15 percent of companies had any sort of collaboration with public research universities between 2012 and 2014. An important component of maximizing the output of R&D in all sectors of France will be collaboration between those sectors—and public policy needs to encourage and facilitate that.

# Ghana

*By: Sam SR, Information Technology and Innovation Foundation*

| Comparative Strengths | Comparative Weaknesses |
|---|---|
| 1. Establishing a Presidential Advisory Council on Science, Technology, and Innovation<br>2. Disseminating Innovative Resources and Technologies to Smallholder Farmers in Ghana<br>3. Opening the Ghana Innovation and Research Commercialisation Centre | 1. Barriers to Innovation<br>2. The Ghanaian Paradox<br>3. Not Following Through on Initiatives |

## Strengths

### 1. Establishing a Presidential Advisory Council on Science, Technology, and Innovation

Although the origins of a Presidential Advisory Council on Science, Technology, and Innovation (PACSTI) can be traced back to at least 2017, it was in January 2019 when President Nana Addo Dankwa Akufo Addo announced the new PACSTI, which will be, "responsible for advising the President not only on matters relating to STI, but also to keep him fully informed about current advances in STI, and their relevant applications towards national development."[61] PACSTI is the first of seven pillars to accelerate national development. Among others, the pillars include: increasing intragovernmental collaboration on S&T policy by coordinating through an "Inter-Ministerial Coordinating Council," greater funding for R&D, greater STEM education, meaningful legislation, and making sure that agriculture, food processing, and environmental problems are being solved with S&T solutions.

### 2. Disseminating Innovative Resources and Technologies to Smallholder Farmers in Ghana

Agricultural activity contributes 19 percent to Ghana's GDP and comprises 45 percent of national employment. A sector tied to other domestic issues of food security, poverty, hunger, and agricultural innovation is immensely important to the country. Agricultural innovation is one of the pillars of the new plan for S&T policy in Ghana. The Agriculture Policy Support Project has been a tool for the Ghanaian government to improve policy and inform government initiatives.[62]

### 3. Opening the Ghana Innovation and Research Commercialization Centre

While the Ghana Innovation and Research Commercialization Centre (GIRC-Centre), doesn't appear to be off the ground quite yet, it will have a particular focus on technology transfer and

the commercialization of the work produced by academia and industry. The Centre will work to, "promote partnership between government, public research institutions, industries, academia, and the private sector to ensure that the collaborations [leads] to enhanced productivity."[63] A part of announcing the Centre was a pledge from President Nana Akufo-Addo that at least 1 percent of Ghana's GDP will go toward R&D, ideally increased to at least 3 percent over time.[64]

## Weaknesses

### 1. Barriers to Innovation

Ghana has dropped in rank in the *2018 Global Innovation Index* from 96 out of 141 in 2014 to 108 out of 143 in 2015. An academic examination of the national systems of innovation in Ghana found that while Ghana has achieved middle-income status as a country, robust innovation policy is necessary to drive further growth.[65] The study surveyed members of the academic community, privately funded research institutes, financial institutions that fund innovation, and high-level officials in government institutions that deal with innovation policy in Ghana. The study recommended a focusing particularly on investment and infrastructure for ICT, and addressing "fiscal and monetary deficiencies" in the Ghanaian national systems of innovation.

### 2. The Ghanaian Paradox and Government Reform

The crux of the Ghanaian paradox is that while by some metrics its economy is strong—particularly in investment, transportation and housing infrastructure, and stable exchange rates—unemployment and indebtedness are extremely high.[66] In order to stimulate innovation in a way that will have a meaningful impact on the aspects of the economy that are hurting a little bit more, it will be vital to address fundamental issues of campaign finance laws and the fact that many contracts tend to be given to people with connections to government officials.

### 3. Not Following Through on Initiatives

While it's good to have a conversation about technology and innovation, and propose new review boards, agencies, and centers, ultimately these projects need to get funded and get off the ground. The evidence of some of the stated "Doing Right" programs end at the discussion level, and it isn't clear at what stage of development or progression they are at the time of writing in March 2019. Talk is good, but action, good policy, and funding are what create meaningful and lasting impact. Ghana should seek to identify ways in which it can follow through on its ambitious and exciting initiatives in technology, innovation, and agricultural policy over the next few years.

# Honduras

*By: Guillermo Peña Panting, Fundación Eléutera*

| Comparative Strengths | Comparative Weaknesses |
|---|---|
| 1. Mi Empresa en Linea<br>2. Digital Government<br>3. Administrative Simplifications and Streamlining Procedures | 1. Slow online System<br>2. Centralized System<br>3. Poor System Credibility |

## Strengths

### 1. My Company Online

Mi Empresa en Linea (My Company Online) is an initiative developed by the Honduran government and Fundacion Eleutera, promoted under the decree 284-2013, and strengthened by the Law of Promotion of Micro and Small Enterprises in 2018. Its main objective is to allow owners of small businesses to register their companies in as little as 20 minutes.

Also, with this platform, the Honduran government seeks to give an incentive to the creation of microbusinesses and small firms. The Central Bank of Honduras announced that only 3 percent of the current portfolio of loans in the banking sector go to such businesses, while maintaining 70 percent of national employment.

The initiative aims to stimulate entrepreneurship through tax relief and deregulation of administrative processes, thereby facilitating the creation of new businesses. This tool unifies the formalities that previously the microbusinesses and small companies had to do in different government institutions.

### 2. Digital Government

The central government has created an organization solely dedicated to electronic government called The Digital Government Unit. It was established under the Government General Coordination Secretary and integrated under the Secretary of Planning and External Cooperation.

In addition, the Digital Agenda 2014–2018 was developed to establish a master plan in 2014, and start the electronic government in its mandate. With the inclination of the government of Honduras, and the support of foreign-aid assistance from the Korean government, a comprehensive and collective master plan of the electronic government is required. The objective of the Honduran government is to have a viable plan for the implementation of electronic government and to achieve better results in the policies established in the Digital Agenda 2014–2018.

### 3. Administrative Simplifications and Optimization Procedures

The Administrative Simplification Commission aims to reach the entire business sector of the country in order to increase both their competitiveness and the growth of their investments. The general purpose of this legislation is to simplify and optimize administrative procedures to ensure all government institutions act in accordance with the rules of economy in a speedy and effective manner.

Also, it eliminates unnecessary or repetitive rules that hinder bureaucratic processes, prevent rationalizing of the provision of public services, and encourage inefficiency and behavior contrary to the public interest. It eliminates arbitrariness in decision-making by diminishing extensive and timely administrative procedures, with the purpose of avoiding undue requirements, alteration of formalities, and legally established deadlines.

## Weaknesses

### 1. Slow Online System

Honduras is currently 127th in the rankings issued by the E-Government Development Index 2016 (EDGI), which mirrors Honduras's low score in the global competitiveness and development indicators of Information and Communication Technologies. Although the country ranks near the bottom, the digital government is carrying out a series of initiatives to make online processes more agile and uncomplicated.

### 2. Centralized Systems

Honduras presents five difficulties inherent to centralism:

1. There are multiple managerial problems that paralyze local development.
2. Administrative difficulties make the relationship between the central government and local authorities difficult.
3. Centralized decision-making hampers the ability to resolve relationships with local authorities.
4. There is a disconnect in the response to local problems.
5. Silo behavior causes doubling and tripling of efforts.

### 3. Low Public Credibility

In the *2018 Latinobarometro Index,* Honduras received a grade of 25 out of 100 regarding the trust its population has in its system of government and institutions, ranking it fifth in the Index, only exceeded by Chile (26 percent), Brazil (33 percent), Uruguay (39 percent), and Costa Rica (49 percent).

# India

*By: Amit Kapoor, Institute for Competitiveness*

| Comparative Strengths | Comparative Weaknesses |
|---|---|
| 1. Enabling Innovation Ecosystem<br>2. Large Talent Pool<br>3. Ease of Doing Business | 1. Strengthening Industry-Academia Linkages<br>2. Investment in Research & Development<br>3. IP Regime |

## Strengths

### 1. Enabling Innovation Ecosystem

The Indian government recognizes the increasing role innovation has played in accelerating economic and social outcomes and enhancing competitiveness around the globe. There is therefore a strong governmental push toward transforming India from a factor-driven economy to an innovation-driven economy.

A major step in this direction was updating the Science & Technology Policy of 2003 to the Science, Technology, and Innovation (STI) Policy of 2013. The STI policy is aimed at utilizing innovative solutions to solve the problems of Indian society. The focus areas of the policy are establishing world-class science and technology infrastructure, providing the right skill sets to youth among all strata, seeding science- and technology -based innovations, and linking contributions of science and innovation to the inclusive economic growth agenda. A National Innovation Council has also been established to advise the government in this regard.

The government's focus on innovation has been a long-term priority for India. The Indian government has also driven the country's innovation policy forward with a sector-specific focus. For instance, back in 1986, the government, recognizing the potential of the biotechnology sector, set up the Department of Biotechnology. As a result of this early push, the sector is now valued at over $12 billion, and the government aims to expand it to over $100 billion by 2025.

### 2. Large Talent Pool

India has a huge competitive advantage over other economies owing to its vast pool of human capital. The country has a population of 1.3 billion, second only to China, with over half the population below 25 years of age. Thus, the demographic dividend for India is immense and opportune.

The country has also managed to leverage its large population through its higher education institutions, especially in the field of engineering and medicine. The vast pool of talent has been one of the key reasons for the successes of the information technology and pharmaceutical sectors in the country. India also has the benefit of the largest English-speaking workforce among developing nations.

However, there is one caveat to India's talent-pool advantage. Despite churning out huge numbers of skilled graduates, there are critical issues of quality and employability among its workers, as the quality of education imparted is so poor and outdated the graduates leaving college usually require further training and skill enhancement from their employers.

### 3. Ease of Doing Business

Over the course of the last few years, the Indian government has taken numerous steps to ease the business environment of the country and dismantle the cobwebs of regulation and bureaucracy that impede business activity. Some of the significant changes that have been brought about pertain to the field of taxation and insolvency regulations.

The notable change in tax laws was the introduction of the Goods and Services Tax, which encapsulated all the numerous taxes that were previously imposed separately at the national, state, and local levels. This single tax has streamlined business processes and made the movement of goods and services across the country faster. The second reform was the introduction of the Insolvency and Bankruptcy Code, which addressed all issues of debt resolution for businesses that were otherwise caught in perpetual limbo. The cost of closing a business, thus, came down with the introduction of the bankruptcy law.

These reforms have significantly reduced the cost of doing business in India, and should therefore attract private capital into the country and encourage innovation at new levels and frontiers.

## Weaknesses

### 1. Strengthening Industry-Academia Linkages

Universities are considered to be hubs of research and innovation around the world. There are two specific roles universities are supposed to play: knowledge creation and knowledge transfer. In India, the latter is often overlooked. Even when knowledge is created despite all the quality issues, the mechanism of knowledge transfer between universities themselves and with industry is quite limited. There are a few issues that arise due to such lack of linkages.

First, as universities work on the same issues in isolation without consulting and collaborating with one another, they fail to create crucial synergy effects, which ends up impeding the flow of knowledge and ideas. Second, the Indian education system is hardly industry-oriented, due to lack of interaction between academia and industry. As a result, industry has to invest in months of intensive training for freshly hired graduates. The government can address this issue by providing a platform for collaboration between industry and academia that would foster greater knowledge creation and dissemination.

A structural reason for the lack of proper linkages between industry and academia is a conflict of interest between the two when it comes to collaborating on innovation. Only a very few universities have an intellectual property rights policy. There is, therefore, a lack of clarity on who owns the intellectual property and how information will be shared between the different parties. Such grey areas make the industry hesitant to collaborate with universities. More broadly, Indian government policies that could encourage technology transfer from universities to the private sector are lacking. To tackle this problem, some countries have introduced collaborative R&D tax credits that provide a more generous research and development (R&D) tax credit for industry research conducted at universities; India could benefit from considering such a policy.

## 2. Investment in Research & Development

India's R&D expenditures are low, not only compared with mature economies, but also compared with emerging economies. India invests 0.67 percent of its gross domestic product (GDP) in R&D, while mature economies such as the United States and Japan invest approximately 3 percent of their GDP. It's worrisome that this percentage has consistently fallen in the last decade after reaching a peak of about 0.86 in 2008.

Moreover, most of this expenditure in India is by the government, which is in sharp contrast to the world trend. In India, the government's contribution to R&D is 52 percent, universities' contribution is 3.94 percent, and business contributes just 43.5 percent. In China, the government's contribution is 16 percent, in the United States it's 11 percent, and in Japan the figure stands at 7 percent. So, the private sector needs to step up in driving the spirit of innovation forward in India.

The impact of this low investment in R&D is clearly reflected in the lack of world-class research facilities in India.

## 3. IP Regime

The two main aspects of India's IP regime at the core of contention between the government and industry are Section 3(d) of the Patents (Amendment) Act of 2005, and the propensity to grant compulsory licenses. Section 3(d) is mainly criticized for setting a higher standard for patentability than mandated by the Trade-Related Aspects of Intellectual Property (TRIPS) agreement. Indian industry believes the additional requirement of enhanced efficacy by the Indian government discourages incremental innovation and detracts from foreign investment. The government, however, maintains its stand that India's Section 3(d) policy is TRIPS compliant. Compulsory licensing gives rights to the Controller General of Patents, Trademarks and Designs to suspend patent privileges in cases wherein the "best interests" of India's citizens are at stake or there is a willful exploitation of patent privileges by the patentee. The industry claims lack of clarity from the government is keeping many firms out of India. However, the government holds the view that the country has used this privilege just once in the past (in a case involving Gleevec, an anticancer drug produced by Novartis).

In such a case, it's important for the Indian government and the industry to lay out a plan of action that will be beneficial for both the innovators and the general public.

# Italy

*By: Stefano da Empoli, President, iCom*

| Comparative Strengths | Comparative Weaknesses |
|---|---|
| 1. Strengthening the Quality of Academic Research<br>2. Promoting the Development of Start-Ups<br>3. Supporting Business Innovation and Digitalization | 1. Improving the Technology Transfer Process<br>2. Attracting Talent From Abroad<br>3. Coordinating Innovation Policy Under a Stronger and Unified Governance Structure |

## Strengths

### 1. Strengthening the Quality of Academic Research

In 2016, Italy was the fifth country in the world in terms of top-cited scientific publications, behind the United States, China, the United Kingdom, and Germany, accounting for almost 4 percent of the world's total.[67] Apart from China, whose rise was spectacular (from 3.86 percent in 2005 to 14.01 percent in 2016), Italy was the only country among the top eight whose share increased during the same period (from 3.25 percent to 3.88 percent), overtaking France, Japan, and Canada. During the period from 2011 to 2014, the growth rate of Italian scientific publications (4.6 percent) was significantly higher than the world (2.9 percent) and the European average (2.7 percent), as well as the OECD average (2.1 percent). In Europe, only Sweden registered a (slightly) better performance (4.8 percent).

An important factor that could partially explain this performance is the establishment, envisaged by Decree-Law No. 286 of 2006 and gradually implemented in the subsequent years, of the Italian National Agency for the Evaluation of Universities and Research Institutes (ANVUR). ANVUR established a quality evaluation of the results of public research in Italy based on objective and transparent criteria and methodologies. Public funding of universities, the main source of money for academic research, is partially dependent on scientific output monitored by ANVUR, as well as the selection and subsequent evaluation of teaching and research personnel (the latter having been enforced since Law No. 240 of 2010 and the subsequent Legislative Decree of 2012).

### 2. Promoting the Development of Start-Ups

The Italian Start-Up Act, introduced by the Decree-Law No. 179 of 2012, aimed at creating a more favorable environment for small, innovative start-ups, by setting up 19 complementary tools. These include digital and zero-cost incorporation, simplified insolvency procedures, tax incentives for equity investments, a public free-guarantee scheme for bank credit, an equity crowdfunding regulation, and a start-up visa program for non-EU tech entrepreneurs. This entire bundle of policy tools provides support to innovative new companies across sectors until the fifth year of their activity.

According to a 2018 evaluation by OECD, the policy framework has had significant effects at both the input and output level. The estimated magnitude of the effects is sizeable, as firms benefiting from these measures achieved increased revenues and added value to their assets that were between 10 percent and 15 percent higher than similar start-ups that had not tapped into the measures.

However, the lack of a significant increase in venture capital (VC) investments prevented a massive upscaling of the many start-ups set up since the approval of the Start-Up Act. For this reason, the 2019 Budget Law includes several initiatives to foster the VC market in Italy, such as the establishment of the National Innovation Fund (NIF), with a starting budget of €1 billion. The NIF will be a multi-funded entity, managed by Cassa Depositi e Prestiti, a joint-stock company owned by the Italian Treasury and banking foundations.

### 3. Supporting Business Innovation and Digitalization

In 2016, National Plan "Impresa 4.0" (Enterprise 4.0) provided a wide array of complementary measures promoting investments in innovation, the digitalization of industrial processes, and an increase in workers' productivity. These included hyper-depreciation and super-depreciation for investments in new capital goods, tangible assets, and also intangible assets such as software and IT systems; a tax credit on incremental R&D costs; a patent box that provides companies with an optional special taxation system that applies to income from the use of intangible assets such as patents, trademarks, industrial designs and models, and copyrighted know-how and software; and tax credit for "Industry 4.0" (Industria 4.0) to strengthen employees' digital skills.

As a result of the plan, private investments grew from €80 billion to €90 billion between 2017 and 2018, with an expected increase of €11.3 billion over the period from 2017 to 2020 in terms of private R&D and innovation spending focusing on Industry 4.0 technologies.

However, the 2019 Budget Law changed some of the measures, e.g., phasing out the super-depreciation and introducing vouchers for innovation advisory services, with a special focus on small- to medium-sized enterprises (SMEs).

## Weaknesses

### 1. Improving the Technology Transfer Process

Despite its high-quality academic research, Italy performs relatively poorly in terms of patent submissions and their time to market. In 2016, Italy ranked 11th worldwide for both equivalent patent applications, with just 31,091 (Germany and France submitted 176,693 and 71,276, respectively), and equivalent patent grants, with only 20,457 (Germany and France received 99,655 and 47,569, respectively).[68] Many start-ups were set up after the Start-Up Act became law, but a tiny percentage were able to scale up (mostly abroad, especially in the United States and the United Kingdom).

A prevalence of small and micro-companies with limited budget availability for R&D investments, and a weak relationship between universities and public research centers, on the one hand, and companies, on the other, are frequently cited as significant factors behind a poor technology transfer process. Moreover, an extreme fragmentation of university and other research-body technology transfer offices and a lack of specific skills and investments in the field are also contributing to this dismal performance.

## 2. Attracting Talent From Abroad

While Italy has been suffering from an increasing brain-drain problem, it has not been able to replace significant outflows of talented people with comparable inflows of entrepreneurs, scientists, and qualified workers.

Measures such as a start-up visa program for non-EU tech entrepreneurs, introduced by the Start-Up Act of 2012, and the favorable tax regime for foreign high-net-worth individuals who choose to move their fiscal residency to Italy, introduced by the 2017 Budget Law, have so far failed to attract a significant number of beneficiaries.

Bureaucracy and language stand as prominent barriers for foreign students and qualified workers in academic courses and workplaces—and also in daily life. Italian academic and research bodies should be encouraged to host non-Italian resident scholars and fellows, also helping them to go through the administrative process for the visa release. The adoption of English should be more widespread, especially in academic programs, both at the undergraduate and graduate level, but also as the main working language (or at least on par with Italian) in large organizations.

## 3. Coordinating Innovation Policy Under a Stronger and Unified Governance Structure

Italy has very fragmented governance, across different layers of government (e.g., local, regional, and central) and several national bodies (e.g., ministries, agencies, etc.). Innovation policy is no exception. Public R&D spending, already low compared with other countries, is sourced through an exorbitant number of organizations without a structured coordination and evaluation system.

The prime minister's office should coordinate both strategy and execution through an innovation council, including national, regional, and local administration representatives, and a special unit in charge of ex-ante and ex-post evaluation of innovation policies.

Moreover, an innovation agency should be set up in order to streamline the technology transfer for universities, research bodies, SMEs, and start-ups. The Agency should be a private entity, under the law, with national and regional governments and business associations as its main shareholders. Therefore, it would be entrusted with the mission of recruiting the most skilled technology transfer experts from the national and international job markets. The participation of business organizations could both bring a suitable management style and ensure the old barriers between academic and research bodies and companies become a relic of the past.

# Korea

*By: Kyungjin Song*

| Comparative Strengths | Comparative Weaknesses |
|---|---|
| 1. Strong Policy Commitment to Innovation-Led Growth<br>2. Highest Tertiary School Enrollment and R&D Expenditures<br>3. Use of Regulatory Sandboxes | 1. Government Intervention and Stringent Regulatory Environment<br>2. Lack of Talent Pool and Industry-Academia-Research Collaboration<br>3. Weak Intellectual Property Rights Policies and Commercialization Activities |

Korea has been ranked highly in various internationally recognized innovation indexes in recent years for its efforts to promote innovation and growth, as table 2 shows.

### Table 2: Korea's rank in various international innovation indexes

| Index | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|
| Bloomberg Innovation Index | 1 | 1 | 1 | 1 (of 60 economies) |
| WIPO Innovation Index | 11 | 11 | 12 (of 128 countries) | N/A |
| WEF Competitiveness Report 2018 (Innovation Capability) | 20 (of 138 economies) | 18 (of 137 economies) | 8 (of 140 economies) | N/A |

Nonetheless, there are strengths and weaknesses in Korea's endeavor toward innovation.

## Strengths

### 1. Strong Policy Commitment to Innovation-Led Growth

The top policy priority of the Korean government is aimed at promoting innovation-led growth by: (1) creating an innovation ecosystem; (2) providing support for basic research; and (3) securing

its global competitiveness in frontier technology capabilities, especially in data, networks, and artificial intelligence (AI). It is expected to help boosting productivity and creating jobs.

In 2019, much policy and financial support is geared toward building an infrastructure for a data-driven economy, 5G commercialization, and industrial utilization of AI. For instance, a government policy strategy for promoting data industry contributed to the expansion of the big data industry by 29 percent in 2018 from the previous year.

### 2. Highest Tertiary School Enrollment and Research and Development Expenditures

Korea has the highest tertiary school enrollment in the world, producing a workforce with high basic skills that has proven to be one of the key factors of the country's economic success within a short span of time (one generation).

Korea has mandated software education across all levels of education since 2018 to help students develop problem-solving skills and prepare them for the future. The number of science and technology-focused universities has increased.

The Korean government has also allocated 20.5 trillion KRW, 4.4 percent of GDP, for research and R&D spending in 2019, which is the highest level in the world. Korea is investing heavily in R&D in frontier technologies such as robotics, AI, 5G mobile communications, and smart cars by providing various investment and tax incentives to companies conducting expensive and risky R&D activities. It also plans to ratchet up its total share of R&D spending on such frontier technologies, from the current 30 percent to 50 percent by 2020.

### 3. Use of Regulatory Sandboxes

A regulatory sandbox has been in place since January 17, 2019, after almost a two-year-long discussion in the National Assembly.

It covers all industries, including ICT, industrial convergence, and regional innovation (fintech, AI, bio/health, etc.). The first regulatory sandbox set up a hydrogen-charging station in the National Assembly.

Under this regulatory sandbox, no process of deliberation or approval will exceed three months to complete (as compared with six months in regulatory sandboxes of other countries). Up to 100 approvals are targeted for this year alone.

Korea's regulatory sandbox is expected to pave the way for a more flexible regulatory framework.

## Weaknesses

### 1. Government Intervention and Stringent Regulatory Environment

The fact that the government has played a more active role in providing research direction and investment in recent years may hinder the private sector in engaging in creative destruction and innovation. And the situation could worsen if it is combined with the regulatory barriers arising from the positive regulatory system. Businesses pinpoint regulatory constraints as the biggest barrier to their global competitiveness. For example, Korea's export of e-government systems halved after

the government introduced the Software Industry Promotion Act in 2013, which prevents large companies from participating in public procurement, with a view toward providing more opportunities to small and medium-sized enterprises (SMEs) that often lack capabilities and know-how.

The divided legislature often finds it difficult to agree on anything, and thus takes much longer than scheduled to review bills, thereby delaying the lawmaking process. For example, only 1 percent of the bills put forward by lawmakers were enacted into law in the first four months of 2019 due to this divisiveness in the legislature.

Furthermore, enforcement ordinances under the jurisdiction of each concerned ministry often tend to have much more power than the law.

## 2. Lack of Talent Pool and Industry-Academia-Research Collaboration

Science and technology-focused universities are witnessing a drop in enrollment in masters and doctoral programs due largely to both a lack of jobs and job insecurity after completion. More often than not, STEM majors are the first choice of top students for the same reason. This phenomenon became striking after the 1997 Asian financial crisis. According to the Korea Statistical Office, combined with demographic change, a deficit of 32,000 professionals is estimated by 2030 in such new industries as big data, AI, and cloud computing. The government has announced plans to foster a talent pool of 40,000 in these areas by 2020.

The problem of weak collaboration between industry, academia, and research institutes persists due to the siloed culture and lack of exchanges (e.g., internship opportunities), along with regulatory barriers. Thus, industry-academia-research partnerships are hard to translate into meaningful commercialization efforts.

## 3. Weak Intellectual Property Rights Policies and Commercialization Activities

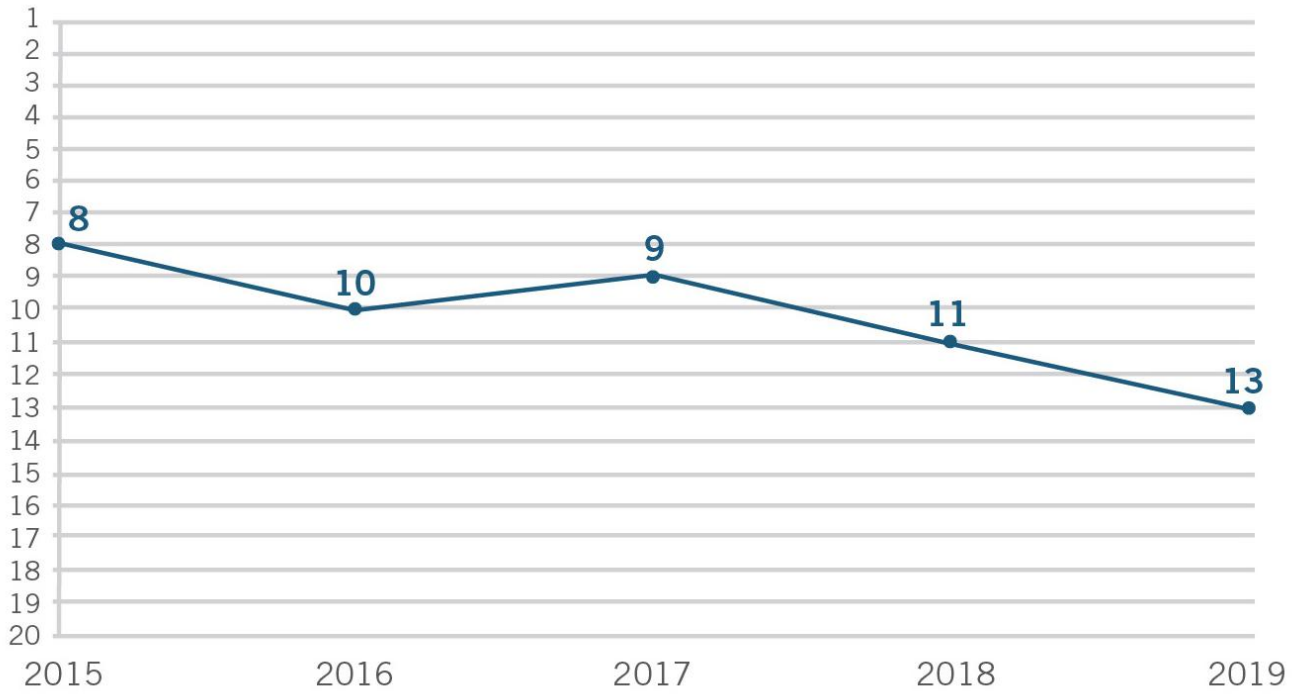
Although, as of 2018, Korea has ranked fourth in the number of patent applications, trailing only the United States, China, and Germany, its commercialization efforts are lagging behind its competitors.

In the period of 2013 to 2017, the number of patent applications totaled 36,166, of which only about 12,000 were transferred to businesses for commercialization. Domestic patent applications accounted for 73 percent (24,351) of cases, whereas only 26.8 percent were international patent applications.

In the period of 1994 to 2010, only 13.5 percent of domestic patent applications were also for patents in the United States. Meanwhile, Israel, which spends as much as Korea in R&D activities, posted 20.4 percent.

One of the reasons the number of domestic patent applications is so high lies in the evaluation criteria—including patent applications, as in the case of government-sponsored R&D activities. Furthermore, researchers are not familiar with the foreign patent application system, which is perceived to be more complicated and costly than the one at home. Korea is not yet a party to the Patent Law Treaty.

## Table 3: Korea's rank on the U.S. Chamber of Commerce International IP Index, 2019[69]




Korea's weak intellectual property (IP) environment is also connected to a lack of openness to globalization. As referenced previously, a global perspective is still lacking in every aspect and level of Korea's R&D and innovation activities. Korea needs to increase its international participation and presence in research, setting of global standards, and commercialization efforts through collaboration with foreign partners. Bringing Korea's IP environment up to global norms will benefit Korea in all of these endeavors.

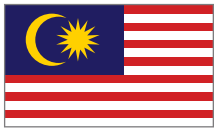
### A Simultaneous Strength and Weakness: Strong Data Protection

Korea's Personal Information Protection Act is very strong on personal data protection and privacy. It is widely applicable to both public- and private-sector entities, including foreign companies that target users from Korea.

On the other hand, due to Korea's very strong data-protection regulations, the vast data compiled in the public company, Health Insurance Review and Assessment Service, remains just a pile of data not subject to utilization for precision health and economic or commercial purposes. An equilibrium should be found between data protection and privacy and data utilization for economic and commercial purposes as soon as possible to support job creation and the development of the data economy to the fullest.

# Malaysia

*By: Lamia Mounavaraly, IDEAS*



| Comparative Strengths | Comparative Weaknesses |
|---|---|
| 1. Improving the Intellectual Property Environment<br>2. Fostering the Start-Up Ecosystem<br>3. Leveraging the Fourth Industrial Revolution | 1. Investment in Public R&D Capacity and Infrastructures Lagging<br>2. Investment in Overall Human Resources and Skills Lagging<br>3. Consolidating Agencies and Institutions in the National Innovation System |

## Strengths

### 1. Improving the Intellectual Property Environment

Since 2003, the Intellectual Property Corporation of Malaysia (MyIPO), under the rule of the Ministry of Domestic Trade and Consumer Affairs, has been in charge of granting the legal and procedural aspects of Malaysian intellectual property (IP) policy. The National Intellectual Property Policy (NIPP) Committee coordinates IP policy, focusing on legal, administrative, and enforcement matters. The main aim of NIPP is to create an environment that encourages creation of IP, provides a high-standard IP-protection system, and builds human-resource capability to successfully implement the policy. The final goal is to make Malaysia a leading IP hub. Malaysia has been a member of the World Intellectual Property Organization since 1989, which ensures the country's intellectual property law meets the requirements of international standards.

Currently, Malaysia is ranked second in Southeast Asia in both the *International Intellectual Property Index* (produced by the Global Innovation Policy Center) and the *International Property Rights Index* (IPRI). On a global level, Malaysia's IPRI score in 2018 dropped by 0.11 points to 6.491, resulting in a drop from 27th to 34th place. On the IP component particularly, Malaysia's score dropped by 0.32 points to 6.105. However, for the *International IP Index* (which measures 45 unique indicators including robust patents, trademarks, copyrights, and trade-secret protections) Malaysia improved its score from 19.47 in 2018 to 22.37 out of 45 in 2019, but dropped overall in its ranking to 24th out of 50 economies worldwide from 23rd in 2018.

In its 2019 *Special 301* report, the United States Trade Representative's Office included Malaysia in its list of countries being monitored for unfair usage of a compulsory license.[70] Although the specific action of the Malaysian government invoking a compulsory license in the case of a well-known drug for Hepatitis-C was not mentioned, this action has raised concerns about the protection of patents in Malaysia.[71]

## 2. Fostering the Start-Up Ecosystem

The Malaysian start-up industry has been growing rapidly in recent years thanks to government programs such as the Malaysian Global Innovation and Creativity Center, launched in 2014, which helps shape a sustainable ecosystem for entrepreneurs and provides training as well as incubation and accelerator programs.[72] Indeed, since its creation, more than 78,000 students and entrepreneurs have benefitted from a variety of its programs, events, and its resource platform.[73]

This has contributed to the development of a large network of private enterprises also investing in mentorship and training programs, resulting in a mix of private incubators, angel investors, venture capitalists, and equity crowdfunding platforms. The main sectors concerned by this growth are big data and analytics, artificial Intelligence, and advanced manufacturing and robotics.

However, today, this ecosystem relies mainly on the local market, as only 10 percent of customers for start-ups in Kuala Lumpur come from outside the country according to the Global Startup Ecosystem Report, which indicates that the main challenge now is to reach the global market by improving global connectedness.[74] The country's proximity to Singapore and its dynamic innovation environment should help stimulate the local ecosystem.

## 3. Leveraging the Fourth Industrial Revolution

In response to the Fourth Industrial Revolution, the *Industry4WRD: National Policy on Industry 4.0* was launched on October 31, 2018, to drive digital transformation of the manufacturing and related services sectors in Malaysia. The aim of Malaysia, through this policy, is to become a primary destination for high-tech industry, a solutions provider for advanced technology, and a strategic partner for smart manufacturing and related services throughout the Asia-Pacific region. To do so, the Ministry of International Trade and Industry plans to act on five points: funding, infrastructure, regulations, skills and talent, and technology. One of the goals is to increase the number of high-skilled workers in the manufacturing sector from 18 to 35 percent.[75] This policy seems to have attracted various actors, as recently companies such as Universal Robots, a Denmark-based collaborative robots market leader, have identified Malaysia as a key growth market—in line with the country's increased focus on automation and robotics. More than 300 small and medium-sized enterprises also applied to be part of this program.[76]

These policies focusing on innovation are coordinated by an agency called Agensi Inovasi Malaysia, which is a statutory body under the prime minister's department. It was created to encourage wealth creation through knowledge, technology, and innovation in order to stimulate and develop the innovation ecosystem of the country.

This is achieved by facilitating collaboration between government, academia, and industry in advancing the consolidation and execution of new ideas in innovation. The various long-term objectives of this agency are to generate additional revenue and contribute to Malaysia's gross domestic product (GDP), provide additional jobs for the Malaysian workforce, inspire and produce a new generation of innovative entrepreneurs, and facilitate the evolution of Malaysian companies into major global players.

## Weaknesses

### 1. Investment in Public R&D Capacity and Infrastructures Lagging

Even though Malaysia's research and development (R&D) landscape has developed over the last decade, with R&D expenditures of around 1.3 percent of GDP, its efficiency is debatable.[77] This figure remains low compared with the world's average spending on R&D of 2 percent of GDP, and developed economies investing around 2.5 percent. In Malaysia, the average R&D spending consists of 0.08 percent of GDP by governments, 0.73 percent invested by the private sector, and a further 0.32 percent by other sources.[78]

Malaysian R&D expenditures by higher-learning institutions, government research institutes, and business enterprises is 20 times higher than what it was 20 years ago. However, one of the main problems is the multiplication of public research assets such as the Malaysian Genome Institute, Agro-Biotechnology Institute, and the Institute of Pharmaceuticals and Nutraceuticals that are not always well coordinated. There is also a concern about the quality and usefulness of Malaysian research publications, even though their quantity has been increasing. The commercialization rates of this research also remains limited due to the lack of funding from businesses and industries.

In October 2018, in order to strengthen the public research sector and encourage R&D funding, programs, and policies, the government confirmed the creation of a centralized research management agency. This agency's aim would be to lead, facilitate, and oversee the R&D sector, thereby improving the management of public research and the agency's collaboration with industry in order to improve the relevance and marketability of public research. Avoiding the multiplication of plans and institutions related to R&D would also help.

### 2. Investment in Overall Human Resources and Skills Lagging

Although Malaysia increased its share of GDP on higher education in recent years, a lack of skilled talent has to be noted. The workforce skill set does not seem to be aligned with technological advances, resulting in a major talent gap. As the country faces a shortage of human capital in science fields, the number of science and engineering students must be increased without decreasing content or quality.

According to the government, Malaysia will need at least 1 million science and technology workers by 2020, out of which 50 percent need to be highly skilled.[79] The target is to gain 500,000 high-skilled workers in Malaysia's workforce by 2020—which seems impossible to achieve by next year, however, as the number of students enrolled in science, technology, engineering, and mathematics (STEM) is constantly dropping. In 2018, only 44 percent of Malaysian students were enrolled in STEM subjects, compared with 48 percent in 2012, which represents a reduction of 6,000 students per year.[80] This decline in interest in science is due to an ineffective teaching methodology and a low level of awareness of the demand of specialized talent.

A study by the Khazanah Research Institute entitled, "The School-to-work Transition of Young Malaysians" reported that around 50 percent of the workforce in unskilled jobs was considered to be overeducated for their roles. A large proportion of STEM graduates working in low-skilled jobs would be one of the reasons why students tend to turn to other fields of expertise. Malaysia thus needs to work on attracting and retaining highly skilled talent to strengthen the human-resource base and avoid a "brain drain" that would be harmful to local industry.

The Ministry of Education launched an ambitious program in 2013 called the *Malaysia Education Blueprint (2013–25)*, whose aim program is to enhance the country's education system by targeting, for example, access, quality, and efficiency of highly skilled, knowledgeable, and united Malaysians. Its main focus is to train more high-end science, technology, and innovation (STI) personnel by strengthening the STEM sector of the education system. The plan seeks to produce 60,000 Malaysian Ph.D.'s by 2025.

## 3. Consolidating Agencies and Institutions in the National Innovation System

One of the main issues often encountered by innovation actors is the multiplication of agencies, ministries, and institutions, which each implementing various schemes and funding programs and initiatives without being interconnected. A survey published by the Organization for Economic Cooperation and Development shows that almost 44 agencies and 10 different ministries are involved in STI programs in Malaysia. This results in a lack of direction in the national research agenda, and fragmented implementation of policy measures. According to the report, this could be narrowed to 14 agencies and 8 ministries, and to avoid redundancies and overlapping functions.[81] It would also facilitate access to information for actors, and allow a better allocation of research funds. Several actors have called for a rationalization of Malaysia's STI governance structure to achieve a higher impact at a lower cost. The monitoring and evaluation of the implementation of policies should also become a central point of innovation programs.

# Mexico

*By: Carolina Agurto Salazar and Rodrigo Corona, Fundación IDEA*

| Comparative Strengths | Comparative Weaknesses |
|---|---|
| 1. Open Data and Access to Public Information<br>2. Intellectual Property<br>3. Industry 4.0 | 1. Public Services Require Digitalization and Digitization<br>2. Need to Invest in Human Capital<br>3. Lack in Funding for Science, Technology, and Innovation |

## Strengths

### 1. Open Data and Access to Public Information

The National Digital Strategy has the goal of building a digital platform in order to enter Mexico into the Information Society. One of the digital enablers to promote the strategy is Open Data, which has more than 40,417 datasets from 278 public entities available on its portal, https://datos.gob.mx. The datasets are divided into 11 topics: culture and tourism; development; economy; education; energy and environment; finance and hiring; geospatial; local governments; infrastructure; health care; and security and justice. All data published can be used by anyone.

Through the National Institute for Transparency, Access to Information and Personal Data Protection (INAI) Mexico wants to guarantee both access to public information, and personal data protection rights. Anyone can request public information, and INAI is obligated to demand the information from the corresponding entity or authority of the executive, legislative, or judicial branch, political party, decentralized autonomous organization, or physical or moral person who receives federal resources, and deliver it to the requester—unless the information is classified as "reserved" or "confidential." The service is online and free.

### 2. Intellectual Property

According to the Secretariat of Economy, IP in Mexico is divided into copyrights and industrial property. The first is ruled by federal laws on copyright and the National Institute of Copyright, the administrative authority that offers different services to national and international authors, especially to the artistic community. The second one is ruled by the Law on Industrial Property, and the administrative organization in charge of protecting the exclusivity, territoriality, and temporality principles of IP is the Mexican Institute of Industrial Property (IMPI).

Since 1975, Mexico has been a member of the World Intellectual Property Organization (WIPO). Some WIPO agreements have granted the Mexican IP parastatal entities—principally IMPI—the faculty of granting patents, trademarks, and industrial designs in order to guarantee the protection of IP both nationally and internationally, and improve competitiveness conditions. Nowadays,

Mexico is among the five countries with the most trademarks registered, and the Mexican Institute of Industrial Property is one of the most important IP-protection institutes in the world.

### 3. Industry 4.0

According to the roadmap "Crafting the Future: A Roadmap for Industry 4.0 in Mexico" (created by the 2012–2018 government in cooperation with the private initiative and academia to begin a strategy for Industry 4.0 introduction), Mexico is not recognized as a leader in innovation, even while being the 13th most-competitive country in manufacturing, and producing more than 80 percent of Latin America's high-tech exports.

However, some strengths in innovation Mexico should take into account in order to introduce the Industry 4.0 agenda are the development of 23 information technology clusters; competitive prices for the production of Industry 4.0 technologies; more competition as a result of telecom reform; wider supply of educational resources identified in Industry 4.0 (automation, computer sciences, data science, electronics, mathematics, mechanical engineering, physics, and statistics); and the development of smart cities.

It should be noted that the Mexican Industry 4.0 roadmap divides the strategic projects by topic and year of possible implementation, including education, technology, and digital economy. These projects conform to the agenda that started in 2016 and will end in 2030.

## Weaknesses

### 1. Public Services Require Digitalization and Digitization

Mexico is the leading country in Latin American and the Caribbean in terms of digital services, and the advances in the digitalization of public services remain constant. The effort of the federal government to achieve the objectives of the National Digital Strategy and offer digital services has had some results. According to OECD, the implementation of the digital government has reduced opportunity costs from 4.3 percent of GDP in 2012 to 2.7 percent of GDP in 2017. Also, the satisfaction with digital public services is high and has more than 1,000,000 users per day. Nowadays, Mexicans can get a copy of their birth certificate on the official webpage, access to Open Data with more than 40,417 datasets from 278 public entities, and participate in the public procurement process. Nonetheless, the progress is slower than in most OECD countries (38 percent from 2014 to 2018) and falls into the "break out" quadrant of the *Digital Evolution Index*.

### 2. Need to Invest in Human Capital

One of the most relevant topics in the national agenda is investment in human capital to improve economic and social conditions. Nowadays, most of the policies regarding the labor force have focused on health and education sectors, as "Seguro Popular" for informal workers and the unemployed; social security through the Mexican Social Security Institute for formal workers, people who wish to enroll voluntarily, students of public institutions, and family members of the insured; free education at all levels; and scholarships for students.

However, the country needs new policies that reflect an advancement in the conditions of human capital. According to the Gini coefficient, Mexico is the third-most-inequitable OECD country—0.46/1.00 rate—and is the OECD country that works the most hours: 2,255 hours/worker per year. One of the

new policies the government wants to implement is the "Jóvenes Construyendo el Futuro" program, which grants scholarships to young people who are neither studying nor working. It's a good start, but Mexico needs to be doing more to address its human capital challenges. The program could take strides toward improving its operation, monitoring and evaluation, and coherence between the result indicators (i.e., metrics) and the program's core pillars and components.

### 3. Lack in Funding for Science, Technology, and Innovation

Since 2002, public investment in science, technology, and innovation has increased despite the fact that the budget allocated for the National Council for Science and Technology has decreased in the last three years. On the other hand, compared with other OECD members, Mexico invests little in science, technology, and innovation. While the creation of technology clusters and other information technology industries has contributed to an increase in the generation of knowledge in the country, government investment is lagging.

Although the generation of knowledge for economic growth in the country is the best incentive to invest in science, technology, and innovation, more fiscal and legal incentives for public, private, and nonprofit sectors are required to increase investment. For now, the short-term goal that must be achieved is to increase investment in this issue to 1 percent of GDP.

# Pakistan

*By: Zia Banday, PRIME Institute*

| Comparative Strengths | Comparative Weaknesses |
|---|---|
| 1. Attracting Foreign Investment<br>2. Establishing Information Technology Parks<br>3. Digitizing Procedures | 1. Allocating Resources for Innovation<br>2. Providing Incentives for Research & Development<br>3. Strengthening Industry-Academia Linkages |

## Strengths

### 1. Attracting Foreign Investment

Getting information technology (IT) infrastructure into the field is playing a vital role in the development of Pakistan's economy. Telecom infrastructure is improving considerably with the assistance of foreign and domestic investment in fixed-line and mobile networks. The government continues to support all credible private-sector initiatives aimed at bolstering the local IT sector and attracting foreign investment. In this regard, numerous incentives have been offered to further attract foreign investment into the IT industry, including no income taxes on IT exports before June 2019, foreign investors permitted 100-percent equity ownership, 100-percent repatriation of capital and dividends allowed, a seven-year tax holiday for venture capital funds, and three-year tax holiday for IT start-ups with no minimum tax or withholding tax. As a result of foreign investments, the country has witnessed quite a few IT breakthroughs over the past several years. For instance, Pakistan has started preparations to test 5G cellular connectivity and is expected to launch this technology by 2020. Moreover, Pakistan's government, in collaboration with the China-Pakistan Economic Corridor, has introduced IT Parks.

### 2. Establishing Information Technology Parks

Software Technology Parks are a major factor in facilitating IT companies and play a significant role in the development of the IT industry. A new state-of-the-art IT Park in Islamabad, spreading over an area 47.7 acres in size, is being financed by the Export-Import Bank of Korea through the Economic Development Cooperation Fund. The Islamabad IT Park's key features include space for 5,000 IT professionals, a Data Center, Incubation Center, Business Centers, and support infrastructure. Pakistan's Ministry of Information Technology and Telecommunication is in the process of establishing such state-of-the-art technology parks in the cities of Lahore and Karachi as well. Currently, 14 Software Technology Parks are providing nearly 1 million square feet of space to IT companies with state-of-the-art facilities in numerous cities, and more are in the development phase.

### 3. Digitizing Procedures

A centralized software solution for financial services has been developed. As the Associated Press of Pakistan has reported:

> Currently Electronic Money Order Service (EMOs), Online computerized collection of all utility bills through Centralized Software Solution has been implemented at the 83 General Post Offices (GPOs) while rollout of Military Pension Payment System at 82 GPOs and 03 Post offices have been implemented. However, Savings Bank and PT Record and Child Support Program (CSP) Services are in customization stage which will soon be implemented in 83 GPOs. Pakistan Post also disbursed pension to 1.3 million retired military personal [sic] through computerized Military Pension Payment System which is available at all GPOs. The pensioners are receiving the pension in a hassle free environment. Pakistan Post is also disbursing pension to over 40,000 [Pakistan Telecommunication Company Limited] pensioners every month. In an effort to streamline payment of pension to PTCL pensioners, Pakistan Post has developed a separate system for PTCL pension disbursement. The same has been rolled out over 83 GPOs.[82]

Moreover, Digitization of Land Records in Punjab is on its way to providing direct access to the general public, banks for loan approval, and other authorities to verify land records instantaneously and without errors. In terms of education, online platforms such as that of the Virtual IT University are improving access in every corner. In elections, voters will eventually be able to navigate to their designated polling stations using their phones and exercise their democratic rights.

## Weaknesses

### 1. Allocating Resources for Innovation

Around the world, governments spend billions on research & development (R&D) to increase agricultural and economic productivity. Unfortunately, however, this has been the opposite case for Pakistan, as it remains one of the least-innovative countries in the world. According to the *2018 Global Innovation Index* report, Pakistan ranks 109 out of 126 countries, owing to the political uncertainty and consistent corruption which has created a discouraging environment for business and handicapped its institutions.[83] The government is more interested in physical infrastructure than intellectual development. There are no government funds to support small and medium-sized enterprises (SMEs) or new entrepreneurial ventures. Banks give loans to only 5 percent of the total SME sector, thus financially depriving them from undertaking R&D.[84]

### 2. Providing Incentive for Research & Development

Switzerland, the top-ranked country on the *Global Innovation Index*, has 57 percent of its researchers from foreign countries due to the numerous incentives offered to them.[85] Unfortunately, in Pakistan, there are no special packages, allowances, or incentives for researchers. The Higher Education Commission did introduce a Tenure Track System (TTS) with high pay scales and other incentives for Ph.D.'s. However, this system is seriously flawed and requires significant modifications to its policies and academic infrastructure. It was meant to be based purely on performance in teaching and research, yet, to the contrary, TTS faculties in most universities have engaged in administrative and nonacademic activities, consequently destroying its fundamental purpose. The lack of adequate incentives for researchers is one of the major contributing factors in this "brain

drain." It is estimated that around 2.8 million Pakistanis have migrated abroad.[86] According to the United Nations Economic, Social, and Cultural Organization, the highly skilled migration rate out of Pakistan increased more than 60 percent from 1992 to 2000.[87] Also, the weak protection of intellectual property (IP) rights is another disincentive for entrepreneurs and researchers to undertake any meaningful ventures or research.

### 3. Strengthening Industry-Academia Linkages

One of the major weaknesses of Pakistan's innovation policy is its weak industry-academia linkage. Pakistani universities are not linked to industry, therefore any research-based products being created at universities is not known by industry—and if industry wants to develop some new innovative products, it does not have the required links with academia. The major reason for this is the lack of research motivation, incentives, awareness, government commitment, and industry motivation to collaborate with universities. Moreover, the paucity of proper arrangements, procedures, mechanisms, and structures for collaboration seems to be one of the most important impediments to collaborative industry-academia linkages.

# Philippines

*By: Ramonette Serafica, Philippines Institute for Development Studies (PIDS)*

| Comparative Strengths | Comparative Weaknesses |
|---|---|
| 1. Embedding Innovation in the New Industrial Strategy<br>2. Strengthening ICT Policy and Planning<br>3. Promoting Competition | 1. Expanding and Improving STI Investments<br>2. Strengthening Linkages Between Knowledge Producers and Users<br>3. Removing Restrictions and Burdensome Regulations and Procedures |

## Strengths

### 1. Embedding Innovation in the New Industrial Strategy

In 2017, the Filipino government launched the Inclusive, Innovation-led Industrial Strategy ($i^3S$, "i-cube"). It is a new approach to industrial policy anchored in competition, innovation, and productivity. Additionally, it aims to build an inclusive innovation ecosystem in recognition of the challenges and opportunities with Industry 4.0. The $i^3S$ is based on five major pillars: 1) building new industries, clusters, and agglomeration; 2) capacity-building and human resource development; 3) micro-, small-, and medium-sized enterprises growth and development; 4) innovation and entrepreneurship; and 5) ease of doing business and improving the investment environment. Stronger linkages between the innovation ecosystem and the entrepreneurship ecosystem are being established as part of the $i^3S$. It's envisioned that the innovation ecosystem will produce a breed of Filipino entrepreneurs that will espouse idea-based, demand-oriented, and research-driven innovation.

Innovation is also part of the Philippines' investment-promotion strategy. Relevant government agencies aim to attract businesses and investments to the country focusing on $i^3S$ priority sectors to facilitate forward linkages to high-value-adding industries and sectors, plus regional and global value chains.

### 2. Strengthening Information and Communications Technology Policy and Planning

In 2016, Republic Act No. 10844, also known as the Department of Information and Communication Technology (DICT) Act of 2015, was passed into law. The law directed DICT to plan, implement, and promote the country's ICT development agenda. While previously ICT concerns were handled by an agency charged with other functions, ICT's elevation to an executive department provides a strong signal of the importance of ICT today. Further, it strengthens the enabling environment for private investment, the coordination of policy dialogue, as well as enforcement regulations

for ICT development. For the purpose of policy and program coordination, three other agencies are attached to DICT: the National Telecommunications Commission (NTC), the National Privacy Commission, and the Cybercrime Investigation and Coordination Center. One of DICT's most notable achievements to date has been the formulation of the National Broadband Plan, which identifies the necessary policy, regulatory, and infostructure interventions required to ensure the delivery of universal, fast, reliable, affordable broadband Internet services throughout the country.

### 3. Promoting Competition

The enactment of the Philippine Competition Act (PCA) in 2015 and the subsequent establishment of the Philippine Competition Commission were significant steps in creating a robust market environment wherein the competitive advantage of firms is sustained through constant improvement and upgrading rather than through the abuse of market power and anticompetitive practices. With the law and commission in place, the government is now formulating the National Competition Policy (NCP) as part of the Medium-term Philippine Development Plan 2017–2022. The NCP aims to complement the PCA and provide a holistic and comprehensive framework for competition. This is to ensure the public and the private sectors work closely to boost market competition by addressing issues such as competitive neutrality, anticompetitive behaviors, and unnecessary regulatory burdens. It is the first time an NCP was included in the country's development plan.

## Weaknesses

### 1. Improving Science, Technology, and Innovation Investments

The bulk (60 percent) of R&D spending across sectors is supported by government. While the Philippines has experienced a slight increase in its R&D-to-GDP ratio in recent years, this spending still accounts for less than one-fifth of 1 percent of GDP, which is below the 1-percent benchmark recommended by the United Nations Educational, Scientific, and Cultural Organization, and the level of spending of several Association of Southeast Asian Nations (ASEAN) member states.

Even if the Philippines invests more on R&D, there are concerns about absorptive capacity as well as complementary factors for innovation that may be absent. There are a lot of missing requirements: sizeable investments, competent human resources, R&D support and incentives, and an improved ICT infrastructure to bring the unconnected groups, especially those in the rural areas, to the digital world.

In terms of investment in human capital, access to high-quality tertiary education should be improved. Funding free tuition for everyone admitted into state universities was recently deemed to be a better alternative to targeted programs. It remains to be seen whether this will affect the structure of enrolment in tertiary education—or whether it will deliver on the promise of greater access, particularly for the poor.

### 2. Strengthening Linkages Between Knowledge Producers and Users

A persistent problem that has been identified in the Philippines national innovation surveys is the very weak linkage between firms and the academic and research institutions. Most higher education institutions (HEIs) perceive collaboration with companies as outside their core mission. Moreover, firms report that convincing HEIs to collaborate with them is difficult because of resentment, suspicion, and distrust. Firms therefore do not tap into the public and private research institutions.

Additionally, education and training need stronger linkages between industry and academia, especially in the area of R&D. Many companies have started to address this gap themselves with investments in on-the-job training programs. Universities have also encouraged their faculty to spend time in industry or with the local community.

While the new industrial strategy aims to strengthen linkages between industry and academia, a national innovation framework and plan of action are required for facilitating interactions between the various players involved in the innovation ecosystems.

### 3. Removing Restrictions and Burdensome Regulations and Procedures

An open trading environment promotes competition and innovation. Based on restrictiveness indices developed by international organizations, FDI restrictions in the Philippines are high by both regional and global standards. The limitations to trade and investment affect a number of key sectors such as telecommunications, transport services, mass media, advertising, education, and professional services, even for former Filipino citizens. The country's ranking in the World Bank's Ease of Doing Business Index has also declined in recent years. To hasten technology transfer and diffusion, there is an urgent need to remove barriers, including the burdensome regulations and procedures that add to the cost of doing business in the country. FDI that will facilitate learning and the shift toward higher-value-added activities should be encouraged.

The current procurement process should likewise be reformed to support the work of those undertaking R&D in or on behalf of the government. The existing procurement system was designed to minimize corruption and increase transparency and accountability in government transactions. However, it has also made it difficult for government agencies to procure external knowledge, technology, and other goods and services needed for innovation activities.

# Poland

*By: Karolina Zubel, Center for Social and Economic Research (CASE)*

| Comparative Strengths | Comparative Weaknesses |
|---|---|
| 1. Addressing the Finance Gap in SME Innovativeness<br>2. Coordinating the Innovation Policy<br>3. Helping Companies in Transition Toward the Fourth Industrial Revolution and Switching to a Digital Business Model | 1. Long-Term Planning and Strategy Creation<br>2. Improving Public Procurement<br>3. Providing Access to High-Speed Internet |

## Strengths

### 1. Addressing the Finance Gap in SME Innovativeness

SMEs occupy a significant place in the national Responsible Development Strategy, being one of the five priority areas under the Specific Objective I - Sustainable Economic Growth Based on Existing and New Advantages. There are many incentives, above and beyond those related to taxes. When it comes to programs administered nationally, apart from the innovation vouchers (Bony na Innowacje), there are two equally important and popular programs. The Research to Market (Badania na Rynek) competition is one of them. The maximum amount of funding in this scheme, guided by the idea "from an idea to the market," is as much as PLN 20 million (approx. $5.2 million). SMEs can apply for financial different kinds of support almost all year round. Loan for Technological Innovations (Kredyt na Innowacje Technologiczne) is an instrument of financial support aimed at increasing the innovation and competitiveness of SMEs by enabling them to implement technological innovations that result from their own R&D or R&D purchased by entrepreneurs (with the latter option arguably having an ambiguous effect on innovation). Support for the entrepreneurs comes in the form of a technological bonus that repays part of the technology loan granted by a commercial bank for the implementation of a technology investment. In this competition, managed by Poland's development bank, Bank Gospodarstwa Krajowego, entrepreneurs can apply for loans of up to PLN 6 million (approx. $1.6 million). The entrepreneur's own funds must account for at least 25 percent of the eligible costs of a technology investment financed from the loan. Moreover, plenty of other initiatives launched by the Polish Development Fund targeting SMEs are currently ongoing. In addition, at the EU level, innovation in SMEs under Horizon 2020 is becoming more and more important within the Polish SME sector.

### 2. Coordinating the Innovation Policy

The government's attempt to coordinate innovation policies is not without its successes. For example, as expenditures for R&D are growing, and new start-ups are being registered almost every day, all activities related to supporting the development of the start-up ecosystem have been collected

in a single program called Start In Poland. Additionally, the Polish Development Fund has been established. This state-owned financial group, operating as a "fund of funds," offers instruments supporting the development of companies, local governments, and individuals. It also invests in sustainable social development and national economic growth. Moreover, the Innovation Council and the Interministerial Team for Innovation are the coordinators of the state's innovation policy, with responsibility over all of the programs and strategies in this respect.

### 3. Helping Companies in Transition Toward the Fourth Industrial Revolution and Switching to a Digital Business Model

The Act on the Future Industry Platform (Ustawa o Platformie Przemysłu Przyszłości) has been recently adopted, and establishes a new entity that will act as an integrator of all the trends related to the Fourth Industrial Revolution. It is supposed to work together with the public and private sectors, and also bring together and coordinate suppliers and recipients of technologies and research centers. Its primary goal will be to bring domestic industry to a level defined as Industry 4.0 in order to increase the competitiveness of entrepreneurs. This will be done by supporting their digital transformation in the areas of processes, products, and business models, using the latest achievements in the field of automation, AI, ICT, machine learning, and broader communication between machines and people. A network of digital innovation hubs is already being created to accelerate this switch.

## Weaknesses

### 1. Long-Term Planning and Strategy Creation

In 2017, the government adopted a document entitled Responsible Development Strategy, also known as the "Morawiecki Plan" by reference to its proponent, the then finance minister and current prime minister, Mateusz Morawiecki. The Morawiecki Plan refers to several innovation-related subjects, at least rhetorically. What is clear is that the strategy seems to promote some old-fashioned industries such as heavy industry (although electric cars, for example, have also been mentioned), bears signs of fiscal profligacy, and promotes state interventionism without an in-depth analysis of externalities or rationale for state intervention. Moreover, some commentators have pointed out that the strategy per se is internally inconsistent and vague. Summing up, there is a strategy on paper, but its real effects are highly uncertain.

### 2. Improving Public Procurement

The Act on Public Procurement (Ustawa prawo zamówień publicznych) includes many useful features, such as innovativeness criteria, competitive dialogue, variants, and participation of experts in the award procedures. But in practice, they are often underutilized. Effectively, the price is still the main criterion. The recently launched GovTech Poland program has been set to put public administration onto a development path based on innovation and modern technologies—and also to create optimal opportunities for the implementation of digitalization in the public administration. "GovTech will ensure that public funds intended to finance the government's operations will be funneled to start-ups and SMEs which can come up with the most efficient and modern ways to spend them." But even if successful, the program will start bearing its first fruits in a couple of months at the earliest.

## 3. Providing Access to High-Speed Internet Connection

According to the European Commission, in 2017, Poland was the second-worst EU country when it came to household access to broadband Internet at over 30 Mbit/sec. Poland is also in the notorious group of four countries (together with Estonia, Romania, and Slovakia) wherein less than 90 percent of households have access to a high-quality network connection (with the EU average of 99.6 percent).

Regardless of the difficulties, the development of IT infrastructure should be a priority for Poland's government and digital service providers. It's a condition of the actual development of the digital market. The growing bandwidth of the Internet means, among other things, the opportunity to enhance e-administration, and a chance to enable more work from home, thus minimizing road traffic and generating environmental benefits. In business, it favors productivity hikes in companies—which is a value for them as well as for the entire economy. The government, it seems, typically does eventually proceed with ambitious plans such as these—and the current Polish national broadband plan foresees 100 percent of households having access to the Internet at speeds of at least 30 Mbps by 2020, and 50 percent of households having internet connectivity of 100 Mbps by then. Unfortunately, given the recent statistics, this scenario seems rather unlikely.

# South Africa

*By: Jasson Urbach, Free Market Foundation*

| Comparative Strengths | Comparative Weaknesses |
|---|---|
| 1. Encourages Academic Excellence<br>2. Transition From Resource-Based Economy to Knowledge and Ideas<br>3. Intellectual Property Rights From Publicly Financed Research and Development Act | 1. Legal Uncertainty With Regard to Property Rights Protections<br>2. Weak Intellectual Property Policy<br>3. Slow and Bureaucratic Regulatory System |

Traditionally, South Africa has had a proud record of upholding IP rights, which was generally lacking elsewhere on the African continent. This is one of the factors that has attracted a relatively high level of foreign investment to the country and contributed to the development of local industry. It has also resulted in South Africans being able to access some of the world's most advanced goods and services, and ultimately, allowed South Africans to become healthier and wealthier. However, for at least the last decade, the South African market has been beset with policy uncertainty.

Consider the Intellectual Property Policy of the Republic of South Africa—Phase 1 (2018). There is an inordinate focus on pharmaceuticals and patents specifically, to the detriment of all other manner of intellectual property such as trademarks, copyrights, industrial designs, etc. However, arguably the greatest threat is the assault on property rights more generally, where the government is seeking to amend Section 25 of the constitution (commonly referred to as the rights clause) to allow for the expropriation of property without compensation. In such an environment, many innovators simply will not innovate, and certainly will not invest, in a country where property rights are under threat.

The uncertain policy environment is reflected in South Africa's slide down the rankings of most cross-country indices. It is this direction of change that is most concerning. To reverse this trend, South Africa needs to adopt institutions that foster innovation and creativity. However, South Africa lacks the basic institutions of economic freedom that include its fundamental foundations: personal choice, voluntary exchange, freedom to compete, and security of privately owned property. Without increases in these central freedoms, it is difficult to envisage how South Africa will be able to grow and become more prosperous.

When it comes to specific policies, there are some "low-hanging fruit" South African policymakers can capitalize on by a simple stroke of the statutory pen. For example, one of the most frustrating problems is the inability of the drug regulator SAHPRA to approve medicines in a timely manner. A lack of human resources is clearly one contributing factor. Another is the government's pro-generics policy, implemented through the Medicines Act in 2003.

This legislation mandates the importation of cheaper drugs from overseas, and the compulsory substitution of innovator drugs with generics within the public health system. The policy naturally

led to an explosion of generic applications at the Medicines Control Council (the predecessor to SAHPRA), and should be scrapped as a matter of urgency.

To address the capacity-constraint problem. SAHPRA should also consider adopting a reference system and not attempting to undertake the entire review process for every new drug application itself, but rather draw on the work of larger, better-resourced foreign drug regulators such as the U.S. Food and Drug Administration (FDA), European Medicines Agency, etc. This would prevent the duplication of efforts, save public money, and speed up access to medicines.

Other countries such as Singapore, Saudi Arabia, and Egypt have introduced drug-approval systems that reference decisions made by the United States' FDA and other advanced-country drug regulators. These policy reforms have slashed their regulatory approval times for pharmaceuticals and are a huge boon to patients waiting to access new drugs. For a middle-income country struggling under multiple health burdens and strapped for resources such as South Africa, this is a sensible, cost-free reform that will save lives.

## Strengths

### 1. Encourages Academic Excellence

Despite the recent turmoil caused by the FeesMustFall movement that led to disruptions at South Africa's top tertiary institutions, South African universities still produce highly qualified scientists and academics.

### 2. Transition From Resource- Based Economy to Knowledge and Ideas

More specifically, the guiding document of the South African government's Department of Science and Technology is called the Bio-economy Strategy.

### 3. Intellectual Property Rights From Publicly Financed Research and Development Act

The basic premise of the Act is to ensure taxpayers' investment in research at government and quasi-government institutions such as universities are protected by patents and other forms of IP protection. This act is based on the United States' Bayh-Dole Act, which was named after the United States senators who sponsored it. The South African government had the good sense to adapt this policy and enact it in domestically. This will create the foundation for a predictable policy environment that could potentially see the next Google come out of South Africa, but only if property rights are protected and enforced.

## Weaknesses

### 1. Legal Uncertainty With Regard to Property Rights Protections

The South African government's efforts to pursue a policy of expropriation of property without compensation is creating regulatory and legislative uncertainty in the country. As a result, many innovators and investors are simply not investing in the country.

## 2. Weak Intellectual Property Policy

The South African government's IP policy calls for a "workable" compulsory licensing system and a nonjudicial mechanism for awarding such licenses. Compulsory licenses allow the government to "break" a patent and give a license to a local manufacturer—or perhaps, in South Africa's case, the proposed state-owned manufacturer, Ketlaphela—to produce a drug. Introducing policies that permit compulsory licensing substantially would weaken South Africa's intellectual property environment in a number of ways. First, it would stifle the nation's entire ecosystem for innovation, as it would give local innovators pause about engaging in entrepreneurial life-sciences activities, for a discovery turned into a novel life-sciences innovation could have its IP forcibly disclosed by the government. Second, foreign companies will perform the same calculus, and be reticent to introduce the newest technologies (including medicines) into South Africa if the IP could be compulsorily licensed. South Africa's own citizens will be harmed if these policies introduce drug launch lag into the country.

## 3. Slow and Bureaucratic Regulatory System

One factor inhibiting the development of a more robust South African biopharmaceutical industry and hindering better access to medicines is the inability of the drug regulator SAHPRA to approve medicines in a timely manner. This bureaucratic inertia is denying thousands of South African patients ready access to medicines that could cure or manage their symptoms.

# Sweden

*By: Andreas Larsson, STUNS, and Stephen Ezell, Information Technology and Innovation Foundation*

| Comparative Strengths | Comparative Weaknesses |
|---|---|
| 1. A Concerted National Innovation Strategy Supports Robust Levels of Public and Private R&D Investment<br>2. Sweden's Smart Industries Strategy<br>3. Flexicurity Approach Smooths Labor Transitions | 1. Difficulty in Enabling Technology Transfer and Commercialization From Universities to the Private Sector<br>2. Stock Options in SMEs Taxed as Income of Labor Rather Than Income of Equity<br>3. Lack of STEM Professionals |

## Strengths

### 1. A Concerted National Innovation Strategy Supports Robust Levels of Public and Private R&D Investment

Sweden's innovation policy environment features robust actors, strategies, and research and development (R&D) investments. Vinnova, Sweden's national innovation agency and a unit of Sweden's Ministry of Enterprise and Innovation, helps strengthen Sweden's innovation capacity by funding research and innovation projects. Founded in 2001, Vinnova and its staff of 200 invests approximately SEK 3 billion ($300 million) in fostering innovation through calls for research proposals in which companies, public-sector actors, and other organizations apply for funding for projects in the early stages of the innovation process.[88] The cause of innovation in Sweden is also supported by the Swedish Agency for Growth Policy Analysis, whose overall objective is to strengthen Swedish competitiveness and create conditions for more jobs in more and growing businesses throughout the country. The agency works on evaluations, analyses, and statistics in a broad Swedish and international perspective, and undertakes analyses of the effectiveness of Sweden's innovation system.[89]

In 2016, Sweden's Ministry of Enterprise and Innovation promulgated the Swedish Innovation Strategy, an integrated, holistic Swedish national innovation strategy.[90] The strategy addresses how Sweden will invest in and develop innovative people; research and higher education for innovation; framework conditions and infrastructure for innovation; innovative businesses and organizations; innovative public services; and innovative regions and environments. The strategy also commissioned the Swedish Agency for Innovation Systems to launch five innovation partnership programs to help meet a range of societal challenges and opportunities Sweden is currently facing with regard to: 1) travel and transport; 2) smart cities; 3) life sciences; 4) the circular and bio-based economy; and 5) connected industry and new materials.[91] Launched on June 1, 2016, these programs engage a partnership between public-sector actors, businesses, and academic centers to create new ways of travelling, residing, doing business, living, communicating, and using and preserving the world's resources and ecosystems.[92]

Sweden's innovation system is supported by robust levels of public and private R&D. Sweden ranks third in the world in national R&D intensity, investing 3.33 percent of its gross domestic product (GDP) in R&D in 2017.[93] Although this level was down from the 3.91 percent it invested in 2001, Sweden is still the European Union's heaviest R&D investor, and trails only Israel and Korea on the global stage. From 2015 to 2017, the Swedish government's investment in R&D grew 16 percent, to SEK 5.6 billion ($560 million).[94] This represented an increase in government investment in R&D of SEK 733 million ($73 million) over the 2015 level. Over this period, business investment also increased by SEK 8.8 billion ($880 million) to SEK 108 billion ($10.8 billion).

## 2. Sweden's Smart Industries Strategy

Sweden has taken strides to ensure it stands at the global forefront of manufacturing digitalization. In April 2016, Sweden introduced a new "Smart Industries" strategy, which includes four core focus areas:

1. Industry 4.0: Exploiting the potential of digitalization;
2. Sustainable production: Improving the industrial sector's capacity for sustainable and resource-efficient production;
3. Industrial skills boost: Ensuring the supply of needed skills for the industrial sector; and
4. Test bed Sweden: Creating test-bed environments for new technologies within Sweden.

The Industry 4.0 component of the Smart Industries strategy seeks to foster "smart industrial companies in Swedish industry that are leaders in digital development."[95] The implementation of Sweden's Smart Industries plan will seek to: 1) Stimulate the development, deployment, and use of digital technologies that have the highest potential to lead industry transformation; 2) Take advantage of digitalization opportunities regardless of company size and geographic location; 3) Encourage new business and organizational models to utilize the potential of new technologies; 4) Meet the needs for new knowledge the digital revolution brings; and 5) Adapt manufacturing frameworks and infrastructure for the digital age.[96]

Sweden will invest over SEK 160 million (almost $18 million) in various efforts to support its Smart Industries initiative. These will include SEK 60 million ($6.5 million) at Vinnova for collaborative projects for the digitalization of Sweden's manufacturing industries as well as SEK 16 million ($1.7 million) for open innovation initiatives in manufacturing firms. The Swedish Agency for Economic and Regional Growth will further invest SEK 78 million ($8.5 million) in a pilot "digitalization boost" program for Swedish manufacturing small and medium-sized enterprises (SMEs).[97]

## 3. Flexicurity Approach Smooths Labor Transitions

Sweden, along with other Scandinavian nations, has pioneered the concept of flexicurity, which commits not to ensuring workers will never get laid off, or paying them for long periods to be unemployed, but to minimizing the number of workers at risk; and then, for those who are laid off, providing support so they can make successful and expeditious transitions.[98] Sweden's flexicurity approach is supported by the second-highest (to only Denmark) public expenditures on active labor market programs as a share of GDP, with Sweden investing about 1.25 percent of its GDP on such programs in 2015.[99]

A key part of Sweden's flexicurity approach is the Trygghetsrådet, a job-security council unique to Sweden that helps laid-off workers. Employers pay into these job-security councils (operated as private organizations), and whenever they lay off employees, those workers receive financial support and job counseling from the council to help get them back into the workforce as soon as possible.[100] The success of the program is reflected in the fact that Sweden leads Organization for Economic Cooperation and Development (OECD) countries in helping displaced workers find new jobs; over 85 percent of such workers find new jobs within a year, primarily because of these arrangements between employers and social partners.[101] Sweden has also found job-security councils make the economy more dynamic because they make it easier for companies to shed unproductive divisions without union resistance, while helping the workers who lose their jobs as a result of these layoffs to find new work.[102] Economists have found that the job security councils have contributed to the overall health of Sweden's labor market. As Andreas Bergh, a professor at the Research Institute for Industrial Economics, explained, "One of the better parts of the Swedish model is that we encourage adjustments by allowing people to enter into training programs, or move to other areas if that is what is needed to find a job."[103]

## Weaknesses

### 1. Difficulty in Enabling Technology Transfer and Commercialization From Universities to the Private Sector

Perhaps the longest-running critique of Sweden's innovation system has been referred to as the "Swedish Paradox" of high R&D inputs but low innovation outputs.[104] As Bitard et al. wrote in their 2008 report "The paradox of high R&D input and low innovation output: Sweden," the productivity or efficiency of the Swedish innovation system remains low, in part due to the moderate growth rate of labor productivity in Sweden, and in part because of globalization, specifically that the internationalization of production by Swedish firms has proceeded further than the internationalization of R&D.[105]

While the situation has improved over the past decade, a particular challenge that persists in Sweden's innovation system pertains to the ability to move technology from academia and research institutions to the private sector for commercialization. As one recent analysis of Sweden's life-sciences sector succinctly put the challenge, "There is currently no effective platform to industrialize ideas from higher education institutions in the life sciences sector." One facet of this challenge may be reflected in the fact that, in Sweden, intellectual property rights stemming from government-funded research at Swedish universities actually go to professors, and not to the universities (unlike in the United States, where the rights go to the universities). But the lack of a strong commercialization culture in Swedish universities—Swedish professors generally want to research, write, perhaps teach, but not commercialize—may stunt the commercialization potential for inventions funded by Swedish taxpayers.

### 2. Stock Options in SMEs Taxed as Income of Labor Rather Than Income of Equity

Growing an SME with a scalable business model (app/ICT/bio/pharma) usually requires the founding team bring in qualified non-founders, as the business requires new skills the founders do not possess. This can be within management, sales, R&D, programming, law, etc. The growing companies are usually strapped for cash (trying not to have too many rounds of funding before positive cash flow is reached), and cannot pay salaries that are comparable with established companies for these key employees. Offering stock options or other incentive-driven programs is therefore important

to remain competitive with international opportunities, and is often offered as a compensation for the risk (going bankrupt as a company) and lower salary. However, Swedish tax law doesn't allow "early stage non-founders" to have stock options as such. Hence, their stock options are taxed as "income of labor" (income tax 56 percent above a threshold/tax bracket) instead of 22 percent (income of equity). Also, the company needs to pay additional "Social Security" fees as the stock options are used. This law makes it hard for early stage, high-growth companies to attract key personnel in the crucial growth phase.

Perhaps in part because of this, Sweden has historically ranked only modestly in indexes of entrepreneurial activity, for instance ranking tenth among high-income countries in 2014 in total early stage entrepreneurial activity in the *2014 Global Entrepreneurship Monitor* report. However, over the past five years, Sweden's rates of entrepreneurship, and perception of the country's entrepreneurship environment, have improved markedly. In fact, today, Sweden ranks highest in the developed world when it comes to perceptions of opportunity: Around 65 percent of Swedes aged 18 to 64 think there are good opportunities to start a firm where they live, compared with just 47 percent of Americans in that age group.[106] Sweden also enjoys a high degree of "intrapreneurship," which refers to when coworkers collaborate on projects outside of their usual assignments. In Sweden, 28 percent of working adults were involved in an intrapreneurial activity in the last three years, compared with 11.7 percent of Americans. Sweden's start-ups also have among the highest survival rates after three years among developed countries: 74 percent of all its start-ups make it past three years.[107] Sweden still has room for improvement, but the country has markedly improved its entrepreneurial ecosystem over the past five years.

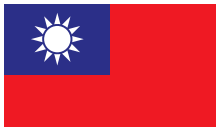
### 3. Lack of STEM Professionals

In order for Sweden to maintain a global edge in information and communications technology (ICT) and tech as well as a high level of innovation and new patents, the number of students in science, technology, engineering, and mathematics (STEM) fields must increase. Today there is a challenge to find skilled staff within STEM fields. A low level of interest in science in combination with a low ranking in the Program for International Student Assessment score in mathematics among Swedish 15-year-olds constitutes a key challenge for the future. Immigration could make a contribution to Sweden's innovative strength, but the opportunity hasn't been appropriately leveraged. Put simply, Sweden has a huge shortage within the whole ICT field: programming, systems architects, etc. For instance, in 2017, the Swedish IT & Telecom Industries and Almega, the Swedish service-sector employers' organization, issued a report, "The IT skills shortage: The Swedish digital sector's need for cutting-edge expertise," which concluded that Sweden would "experience a deficit of around 70,000 people with IT or digital-related competencies by 2022" if no measures were taken to halt the decline.[108]

To address this challenge, in 2017, Swedish prime minister Stefan Löfven's commissioned an expert working group on the issue, which concluded that Sweden needs a more-liberalized national labor policy that links skills-based immigration to national development and growing core areas of industry, including the country's expanding IT and digital technology base.[109] Indeed, a greater innovation orientation in Sweden's high-skill immigration policy could help the country tackle these challenges.

# Taiwan

*By: Taiwan Institute for Economic Research (TIER)*



| Comparative Strengths | Comparative Weaknesses |
|---|---|
| 1. Supporting Open Data Policy<br>2. Improving On the Digital Divide<br>3. Funding Innovative Science and Technology Projects | 1. Need More Innovation in Public Procurement<br>2. Lack of a Comprehensive Digital Government System<br>3. Increasing Foreign Innovative Talent |

## Strengths

### 1. Supporting Open Data Policy

In 2014, Taiwan's ranking in the Global Open Data Index was 11th. In 2015 and 2016, Taiwan ranked first. The Global Open Data Index survey, conducted by the Open Knowledge Foundation, is designed to assess the openness of government datasets. Taiwan received full marks in Government Budget, National Statistics, Procurement, Administrative Boundaries, Draft Legislation, Air Quality, National Maps, Weather Forecast, Company Register, Election Results, Locations, and Land Ownership indexes. However, Water Quality, Government Spending, and National Laws indexes were identified as areas where Taiwan needs to improve.

Taiwan's government highly supports open data and is implementing an Action Plan of Open Data in which government organizations, at every level, will be required to have an open data committee and establish open dataset goals. Committee members monitor the openness of open data and discuss whether datasets cannot be opened because of privacy or other issues. Basically, open datasets follow three basic rules: 1) Open datasets are for the use by citizens and enterprises; 2) Most open datasets are free, and 3) Open datasets are released and exchanged automatically. Taiwan has an open data portal (http://data.gov.tw) which includes more than 38,642 datasets. The number of datasets is still increasing every year, and datasets have improved in accuracy, usability, and immediacy. The government also has created an open-data application programming interface (API) platform, making datasets available in multiple formats such as .json, .xml, .csv, .xls, etc.

In an effort to maintain its first-place ranking in the Global Open Data Index, the Taiwanese government is funding projects for those who are trying to start open data business models. Every year, many open data competitions are held to find out the best open-data practices. In addition, to encourage the use of open datasets to solve problems, several events with different themes, such as Hackathons, Data Jams, and Datapaloozas, are being held.

### 2. Improving On the Digital Divide

For ICT hardware, the government has broadened bandwidth and built digital infrastructure in all elementary schools. For software, to enhance information technology, the typical curriculum from first grade through ninth grade includes a digital literacy component, and building calculation abilities. At the same time, the training of teachers is also critical to their success. The IMD World Digital Competitiveness Ranking 2018 ranked Taiwan second in the number of mobile broadband subscribers per capita.

### 3. Funding Innovation Science and Technology Projects

Taiwan's government has funded science and technology projects every year, and the amount of which has increased year by year. In 2019, it will be about NTD 120 billion ($4 billion), with a 5-percent growth rate. The projects include digital economy fields, such as big data and artificial intelligence (AI), AI on chips, AI semiconductors, 5G, quantum computers, satellites, etc. The funding also targets the government's "5+2 Industrial Innovation Plan." The 5+2 "pillar industries" are the Internet of Things (also referred to as "Asia Silicon Valley"), biomedical, green energy, smart machinery, defence, high-value agriculture, and the circular economy.

## Weaknesses

### 1. Need More Innovation in Public Procurement

According to the Government Procurement Act, there is no specific law to encourage the public sector to procure innovative goods or services. Most of the procurement personnel in government departments seek to avoid violation of the Anti-Corruption Act through the implementation of open tendering procedures and choosing the lowest tender within the budget amount and government estimate. This means only the lowest price determines the procurement results, instead of the innovation level of the goods or services. The innovation goods and services, in particular, are mostly more expensive. In 2017, the Ministry of Economic Affairs (MOEA) launched a new regulation called "MOEA Innovative Goods and Services Procurement Priority Regulation." It is an important step for the government to procure innovation. However, among government ministries, it has only been adopted by MOEA.

### 2. Lack of a Comprehensive Digital Government System

Digital Nation and Innovative Economic Development Program (2017–2025) is a plan to pursue the goal of a "Digital Nation, Smart Island." However, the main program is to build digital innovation infrastructure, so the digital government focuses on civic participation, open government, and intelligent government. Within the central government organization, it lacks a specific department of information and technology and chief information officer. It is easy for citizens to download documents from government websites, although it can sometimes be difficult to find the right ones. The government's website layout and functionality should be designed in a more user friendly way. Moreover, better communication with citizens is needed, so Taiwan would benefit by reorganizing and clarifying the layout and functionality of government websites.

## 3. Increasing Foreign Innovative Talent

In order to attract foreign professional talent, the government launched Contact Taiwan Program in 2015, Foreign Professionals Act (or Act for the Recruitment and Employment of Foreign Professionals) in 2017, and New Economy Immigration Law in 2018. However, there are only 31,049 foreign professionals working in Taiwan, and there are large talent outflows to other countries. The IMD World Digital Competitiveness Ranking 2018 ranked Taiwan 55th in Foreign Highly-Skilled Personnel, 49th in Cost-of-Living, 45th in Attracting and Retaining Talents, and 51st in "Brain Drain." The positive factor is  eighth place in Effective Personal Income Tax Rate. There exists the need to have more effective policies to lower the cost living, increase salaries and wages, etc.

# United Kingdom

*By: Sam SR, Information Technology and Innovation Foundation*

| Comparative Strengths | Comparative Weaknesses |
|---|---|
| 1. "U.K. commits to International Research and Innovation Strategy"<br>2. Creation of United Kingdom Research and Innovation<br>3. Strong European Innovation Scoreboard Indicators and Global Innovation Index Rankings | 1. Brexit<br>2. Historic Lag in R&D Funding<br>3. "Unprecedented peacetime slowdown in productivity growth" |

## Strengths

### 1. "U.K. commits to International Research and Innovation Strategy"[110]

Announced by the science minister for the United Kingdom, Chris Skidmore, the United Kingdom will be investing £4 million in competition funding for EUREKA projects. The United Kingdom aims to increase R&D investment to 2.4 percent of GDP. The £4 million is divided into several categories: £1 million for medical technology and smart mobility through GlobalStars, £2 million for smart manufacturing, and £1 million for artificial intelligence and quantum. The full commitment is £7 billion in research funding over five years, through 2022.

### 2. Creation of United Kingdom Research and Innovation

Created in 2018, United Kingdom Research and Innovation (UKRI) is a nongovernmental organization that is funded by the Department for Business, Energy, and Industrial Strategy. It works to supervise and coordinate existing research institutions. The organization will dispense, through the seven constituent disciplinary councils, £3 billion in peer-reviewed grants annually, and Research England will provide another £3 billion of unrestricted grants to universities.[111] UKRI has been specifically tasked with generating clear economic benefits of science- and technology-research funding. It is unclear whether this money is a consolidation of funding that previously existed at these disciplinary councils, or from new sources. UKRI is autonomous, which has raised some concerns from the scientific community regarding how decisions regarding grants are made or denied. But it will take a few years and grant-proposal cycles to see what improvements need to be made to the system in order to maximize the return on public dollars to research.

### 3. Strong European Innovation Scoreboard Indicators and Global Innovation Index Rankings

The United Kingdom is consistently ranked highly as an innovation leader on the European Innovation Scoreboard, ranking fifth in 2018.[112] It also ranks highly on the Global Innovation Index Ranking, up from rank 5 to 4 for 2018.[113] A significant amount of global R&D investment comes out of Europe (and consequently the United Kingdom) for how low the region's population is compared with the rest of the world. Despite these indicators, however, financial investment has historically lagged. Recent announcements hope to combat this, and ideally will maintain the United Kingdom's rankings in the various indices.

## Weaknesses

### 1. Brexit

Without commenting significantly on the other implications of Brexit, the United Kingdom's exit from the European Union brings significant complications to innovation and trade. It's yet to be determined what the final plan for Brexit will be, but, as *University World News* reports, "Under the proposed Horizon Europe arrangements, the U.K. in the event of a no-deal Brexit would be classed as a third-country and along with Switzerland and would see its position 'severely threatened', according to Lidia Borrell-Damian, the European University Association's director for research and innovation, unless an agreement for full associated participation is separately agreed."[114] Moreover, the ability of EU citizens to move freely between member states for work allows talent from other countries to come work in London, a major tech city, and contribute to the British economy. Making labor immigration more difficult by not maintaining the status quo would impact the ability of London-based companies to bring in talent, which hurts innovation.

### 2. Historic Lag in R&D Funding

Public R&D funding has been relatively flat since the financial crisis, though the private sector has stepped up to make up for it.[115] For instance, in 2016, total R&D expenditure in the United Kingdom as a share of GDP represented just 1.67 percent of UK gross domestic product, ranking the country only 11th among European countries in national R&D intensity.[116] The recent announcement by the science minister is promising, but that money needs to actually get into the hands of innovators and companies with strong ideas. Hopefully, UKRI, as well as the recent innovation and research strategy announcement, will assist in that regard. A strong commitment is good, but follow-through and effective management of funding allocation are important to maximize the value to the economy.

### 3. "Unprecedented peacetime slowdown in productivity growth"[117]

The stagnation—and decline—of productivity growth is not United Kingdom-specific problem.[118] However, the Sheffield Political Economy Research Institute (SPERI) claims this is "probably the U.K.'s most serious current economic problem." This may be true for other major countries, but the United Kingdom currently sits at a 45-year low. The United Kingdom is significantly behind the G7 average compared with other major countries. The lag in R&D funding certainly has contributed to this.

# United States

*By: Stephen Ezell, The Information Technology and Innovation Foundation*

| Comparative Strengths | Comparative Weaknesses |
|---|---|
| 1. Launch of Manufacturing USA<br>2. Effective Measures to Promote Technology Transfer and the Commercialization of Federally Funded R&D<br>3. Robust Intellectual Property Protections | 1. Faltering Federal R&D Investments<br>2. Weakening Incentives to Spur Private-sector Sector R&D Investment<br>3. Lack of Institutional Home for Innovation Policy |

## Strengths

### 1. Launch of Manufacturing USA

In 2012, the Obama administration launched America Makes, the first Institute of Manufacturing Innovation (IMI), one of 14 that now constitute Manufacturing USA, a public-private partnership that brings together industry, academia, and government partners to leverage existing resources, collaborate, and co-invest to nurture manufacturing innovation and accelerate commercialization.[119] Manufacturing USA has played a pivotal role in revitalizing America's industrial commons and helping ensure U.S. leadership across a range of advanced-manufacturing process and product technologies.[120] Manufacturing USA is probably the most significant institutional innovation made to the U.S. innovation system in the past four decades. Today, the 14 IMIs comprising Manufacturing USA focus on advanced manufacturing product and process technologies related to advanced functional fabrics, photonics, additive manufacturing (3D printing), robotics, biofabrication, clean-energy smart manufacturing, advanced lightweight composite materials, digital manufacturing, flexible hybrid electronics, biopharmaceutical manufacturing, advanced semiconductor components, chemical and material processing, and remanufacturing of materials.[121] In 2017, Manufacturing USA's 1,291 members (of which 844 are manufacturing firms and 549 are small businesses) conducted nearly 270 major applied R&D projects of high priority to broad manufacturing industry sectors.[122] Manufacturing USA is also playing an important role in supporting U.S. manufacturing workforce development, with institute-led workforce efforts in advanced manufacturing, educator and trainer instruction, and science, technology, engineering, and mathematics activities in 2017 resulting in over 191,000 workers, students, and educators participating in Manufacturing USA-led workforce efforts—a seven-fold increase over the prior year in the number of individuals enriched by the program.[123] Manufacturing USA will remain a vital component supporting U.S. manufacturing competitiveness going forward.

## 2. Effective Measures to Promote Technology Transfer and the Commercialization of Federally Funded R&D

While there's always opportunity for improvement, the United States has made significant strides in its environment and policies supporting technology transfer and commercialization of federally funded R&D. Instrumental to this success has been the Bayh-Dole Act, bipartisan legislation from 1980, which gave universities, small businesses, and nonprofit institutions rights to the IP stemming from federally funded research undertaken in contracting organizations. The legislation was hailed by *The Economist* as, "Possibly the most inspired piece of legislation to be enacted in America over the past half-century. Together with amendments in 1984 and augmentation in 1986, it unlocked all the inventions and discoveries that had been made in laboratories throughout the United States with the help of taxpayers' money. More than anything, this single policy measure helped to reverse America's precipitous slide into industrial irrelevance."[124] Since its enactment, the Bayh-Dole Act has played a catalytic role in getting the results of federally funded scientific research off of shelves and into marketplaces where it can benefit citizens and society.[125] The legislation also has led to a dramatic rise in innovation activity at U.S. universities. For instance, while by 1976 only 55 U.S. universities had been granted a patent, 240 universities had been issued at least one patent by 2006.[126] Similarly, in 1980, only 390 patents had been awarded to universities; but, by 2009, that number had increased almost tenfold to 3,088. According to a report prepared for the Association of University Technology Managers (AUTM) and the Biotechnology Industry Organization, from 1996 to 2015, academic patents and their subsequent licensing to industry—substantially stimulated by the Bayh-Dole Act—bolstered U.S. gross domestic product (GDP) by up to $591 billion, contributed to $1.3 trillion in gross U.S. industrial output, and supported 4.27 million person years of employment.[127] Moreover, almost 300 drugs and vaccines have been developed through public-private partnerships since the Bayh-Dole Act entered force in 1980. In short, the Bayh-Dole Act has been a pivotal enabler of the U.S. innovation system.

Another set of programs has made important contributions to stimulating U.S. innovation: the Small Business Innovation Research (SBIR) and Small Business Technology Transfer Research (STTR) programs. SBIR is a set-aside program in which 11 federal agencies (all those with R&D budgets greater than $100 million annually) participate, and was designed for small businesses to engage in federal R&D with robust potential for commercialization. In 2017, 3.2 percent of these agencies' budgets were allocated to the SBIR program. In 2017, 0.45 percent of federal-agency research budgets of greater than $1 billion annually went to STTR, a sister set-aside program designed to facilitate cooperative R&D between small business concerns and U.S. research institutions with potential for commercialization.[128] Together, SBIR and STTR provide over $2.5 billion annually to support small businesses engaging in R&D with commercialization potential. Since its inception, SBIR has granted over 160,000 awards, with total grants awarded to research-intensive small American businesses now exceeding $43 billion. On average, SBIR-supported companies receive 10 patents each day, which is a testament to the innovative prowess of the more than 450,000 engineers and scientists working in companies that have been SBIR-supported.[129] Over the first 30 years of the program (according to data provided in 2013), SBIR grants engendered 70,000 issued patents and supported the launch of almost 700 public companies, with those companies attracting approximately $41 billion in subsequent venture capital investment.[130] Companies launched in part with SBIR support feature a "who's who" of some of America's most successful innovators, including 23andMe, Amgen, Apple, Biogen, Jarvik Heart, LIFT Labs, Millennium Pharma, Qualcomm, Symantec, and iRobot. The SBIR program has been so successful, it's been copied by 17 countries and a number of U.S. states. While there is opportunity to improve these programs, they have greatly increased the extent of private-sector commercialization of innovations derived from federal R&D.[131]

### 3. Robust Intellectual Property Protections

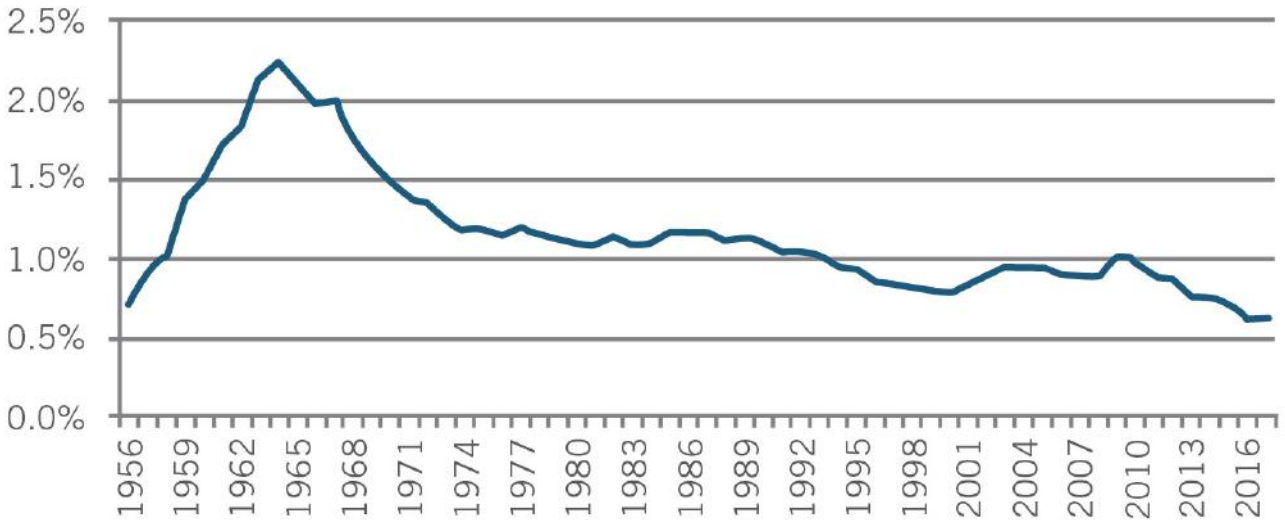
It's very difficult to achieve innovation without the protection of ideas. So important are IP rights that America's founders enshrined them in the U.S. Constitution, Article 1, Section 8, giving Congress the power, "To promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries." Robust IP protections provide innovators with the confidence to undertake the risky, expensive, and difficult process of innovation, secure in the knowledge they can capture a share of the returns from their successful innovations—which also engenders a virtuous cycle of innovation, such that profits from one generation of innovation can be applied to investment toward the next. From patents and trade secret protections to copyrights, trademarks, and service marks, the United States leads the world in providing IP protections—and a secure environment to enforce them. That's why the United States continues to lead the world in international indexes of IP, such as the Global Innovation Policy Center's *2019 International IP Index*.[132] While the U.S. IP system does have areas to improve, including reigning in the Patent Trial and Appeal Board and providing greater certainty regarding patentability for high-tech sectors, the U.S. IP system continues to be looked to as a world leader and plays a vital role in catalyzing America's innovation system.

## Weaknesses

### 1. Faltering Federal R&D Investments

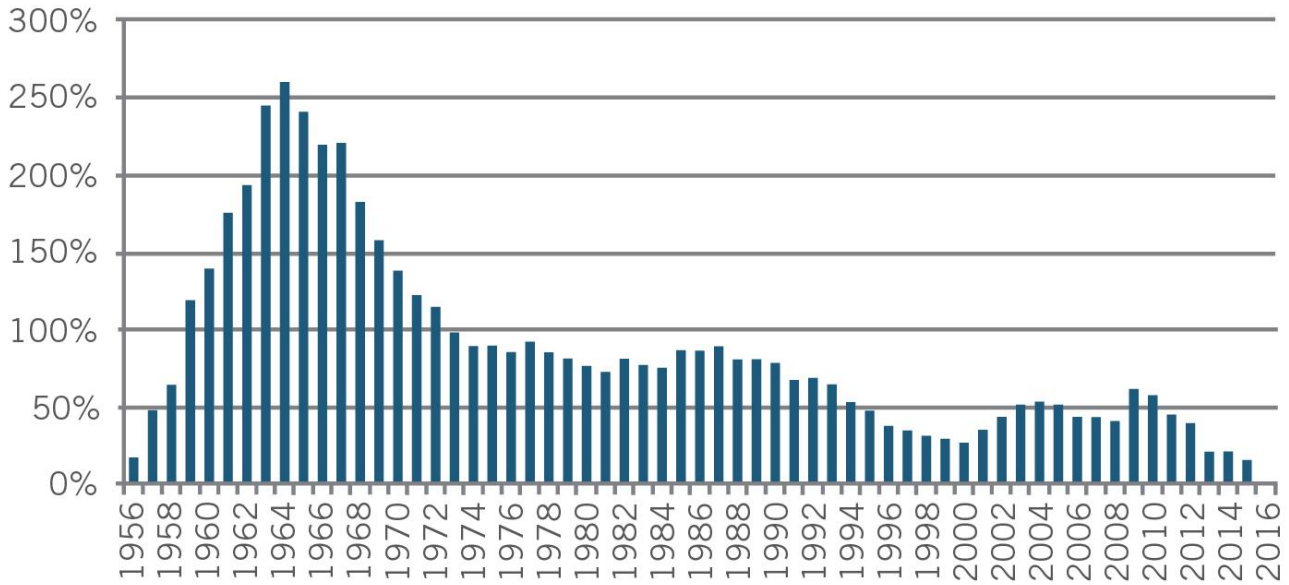
The U.S. federal government is significantly underinvesting in R&D compared with both its own historical norms and peer nations. In FY 2017, the federal government invested $125.3 billion in R&D.[133] While a seemingly high number, federal R&D investment as a share of GDP in FY 2017 actually fell to 0.62 percent, the lowest level since 1955, as figure 2 shows.[134] That faltering federal R&D investment also manifests itself in international comparisons, as the United States has fallen from fifth among Organization for Economic Cooperation and Development (OECD) nations in R&D intensity (total national investment in R&D as a share of GDP) in 2000, to eighth in 2017.[135]

**Figure 2: Federal R&D as a Share of GDP**



To understand just how far off the historical pace federal funding for research has fallen, figure 3 shows how much 2017 R&D funding levels would need to increase in order to match past U.S. R&D-to-GDP ratios. For example, to match levels from the 1980s, federal R&D funding levels in 2017 would have needed to be about 80 percent higher than they were.

**Figure 3: Increase in 2017 Federal R&D Spending Needed to Match Past R&D-to-GDP Ratios**




These declines are also appearing in federal funding of university R&D, with a recent ITIF study finding that the United States had fallen to 24th of 39 nations studied in government funding of university R&D as a share of GDP.[136] In short, relative to the size of its economy, and even to its own historical norms, the United States' federal government needs to significantly increase its R&D investments. ITIF has called on Congress to increase federal R&D funding by at least $40 billion over the next five years.

## 2. Weakening Incentives to Spur Private-Sector R&D Investment

The United States introduced the world's first R&D tax credit in 1981, and until the early 1990s had the world's most generous R&D tax credit. R&D tax credits matter because they stimulate private-sector investment. For instance, a study of nine OECD nations by Bloom and Griffith found that every dollar of R&D tax expenditure stimulates approximately one dollar of business R&D.[137] Unfortunately, U.S. R&D tax-incentive generosity has faltered considerably, now slipping to 27th in a recent ITIF study of 42 nations.[138] Countries such as Brazil, China, and India now offer more generous R&D tax credits than does the United States.[139] Elsewhere, the United States is underinvesting in capital equipment and workforce training. For instance, U.S. business investment in capital equipment, software, and structures grew by 2.7 percent per year on average during the 1980s, and 5.2 percent annually during the 1990s. However, from 2000 to 2011, it grew by just 0.5 percent, and, as a share of GDP, business investment has declined by over 3 percentage points since the 1980s.[140] Similarly, corporate investment on worker training fell by 30 percent as a share of GDP from 1999 to 2015.[141] Likewise, federal funding for employment and training has fallen by about half as a share of GDP from the mid-1980s to present.[142] To tackle these

challenges, ITIF has called on Congress to either increase the alternative simplified credit for R&D from 14 percent to 20 percent, or expand it by enacting a three-tiered credit for qualified expenses that are 50 percent, 75 percent, or 100 percent above firms' previous three-year averages. At the low end, they would continue to receive a 14-percent credit; in the middle band, they could receive a 20-percent credit; and at the high end, they could earn a 40-percent credit.[143] Further, as a dozen other countries have, Congress could introduce a collaborative R&D tax credit that broadens and expands to 20 percent the R&D credit for collaborative research conducted by industry at universities.[144]

### 3. Lack of Institutional Home for Innovation Policy

As ITIF wrote in "Understanding the U.S. National Innovation System," the United States operates a wide variety of institutions that support scientific research, innovation, and the development, transfer, and commercialization of new technologies. However, as that report points out, "In general, U.S. innovation policy is less sophisticated and less well thought out than it is in many other nations."[145] And as ITIF pointed out in its report "The Global Flourishing of National Innovation Foundations," more than 50 countries throughout the world that have created government-chartered entities specifically charged with promoting innovation.[146] But the United States lacks a similar institution. That's why ITIF has called for creation of a National Innovation Foundation (NIF) that would represent a nimble, lean, and collaborative entity devoted to supporting firms and other organizations in their innovative activities.[147] A NIF could help address several challenges to U.S. innovation policy. Initiatives are underfunded and scattered throughout government. Federal policies do little to support effective state and local initiatives; and they pay little attention to the service sector and to the important roles that smaller firms and universities play in the commercialization process. A U.S. NIF would fulfill several important roles, including: (1) catalyzing industry-university research partnerships; (2) expanding regional innovation-promotion; (3) encouraging technology adoption; (4) supporting regional industry clusters; (5) emphasizing performance and accountability; (6) championing innovation with the federal government; and (7) serving as an expert resource on innovation to other agencies. Another reason the United States should establish a NIF is to give innovation an institutional home, like science has with the National Science Foundation (NSF), insulating innovation to some extent against political change, and providing a greater degree of continuity across administrations.

Another way this could be implemented would be by creating a National Engineering and Innovation Foundation consolidating the current Engineering Directorate within NSF, including the Engineering Research Center and Industry/University Cooperate Research Centers programs, the functional parts of the National Institute of Standards and Technology, the Department of Defense's Manufacturing Technology program, and the Department of Energy's Advanced Manufacturing office into a single entity with an engineering focus. The new National Engineering and Innovation Foundation would consolidate existing budgets from the merged programs, and also add $300 million per year to ongoing funding.[148] Whichever approach is used, the United States needs an institutional home for innovation policy.

# Endnotes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44. The views expressed in the European Union section are those of the author alone and may or may not correspond to the views of the Lisbon Council or any of its associates.

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