The Global Flourishing of National Innovation Foundations

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Some 50 nations have now launched national innovation foundations and written national innovation strategies in an effort to maximize the innovation output of their enterprises and organizations.

As the race for global innovation advantage accelerates, a growing number of countries continue to do all they can to maximize innovation-based economic growth in their nations. Increasingly, this has taken the form of countries establishing national innovation foundations and articulating national innovation strategies in an attempt to coordinate disparate policy areas and government agencies in a coordinated manner to promote innovative activity by commercial, nonprofit, and government actors in their economies. Some 50 nations now field national innovation foundations; this report assesses the roles they play and some of their successes to date.

Innovation is, to all appearances, an idea whose time has come. Innovation has featured as a major theme in all of President Barack Obama's State of the Union addresses and the administration is in the process of developing a third version of its *Strategy for American Innovation*, to be released in spring 2015.[1] Yet innovation's high profile in political discourse is not distinct to the United States; innovation was the overarching theme of the "12th Five Year Plan" of the People's Republic of China, and British Prime Minister David Cameron has made innovation the central part of his call for Britain to develop a modern industrial strategy.[2]

Frequency of invocation can rob a term of its meaning, but "innovation," at least in a policy context, has so far managed to retain and even sharpen its significance; the Organization for Economic Cooperation and Development (OECD) offers this handy definition of innovation as "the implementation of a new or significantly improved product

(that is, a physical good or service), process, a new marketing method, or a new organizational method in business practices, workplace organization, or external relations." While this is a good definition, innovation put simply is about the creation of new value for the world.

Public rhetoric is, of course, hardly synonymous with action. American presidents and British prime ministers have been talking up "innovation" since at least the 1970s, but efforts to promote innovation through direct government action or support for innovation infrastructure have been inconsistent at best. Meanwhile, a number of America's leading competitors have aggressively launched national innovation foundations or agencies specifically designed to promote innovation within their home countries. In some cases, these are government agencies (such as Uruguay's National Research and Innovation Agency or the Danish Agency for Science, Technology, and Innovation), while others are autonomous or quasi-autonomous non-governmental organizations (such as the Finnish Funding Agency for Technology, Tekes, or the United Kingdom's National Endowment for Science, Technology, and the Arts, "NESTA").

The best national innovation foundations and strategies are lean and nimble, able to shift their operations and priorities at the speed at which modern innovation and technological development unfolds.

Table 1 lists 30 out of the more than 50 countries throughout the world that have created government-chartered entities specifically charged with promoting innovation. Some, like Finland, even have two national innovation foundations—in Finland's case, Tekes focuses on commercial innovation while SITRA (Finland's first innovation foundation) focuses on government and social innovations. While the oldest agencies, such as SITRA and Brazil's FINEP, date back to the late 1960s, the majority spawned within the last 15 years, during the Information Age. They are to be found in economies of all sizes and stages of development, from Colombia, Ghana, Kenya, and Uruguay to India, Indonesia, and Japan. Moreover, many innovation agencies in Central and Eastern Europe emerged from the effort to maximize the impact of European Union (EU) Structural Funds dedicated to research and innovation in these countries. An initial survey shows a wide spectrum of budgets and organizational mandates, suggesting that the construction and direction of a national innovation foundation may still be as much an art as a science. The best national innovation foundations and strategies are lean and nimble, able to shift their operations and priorities at the speed at which modern innovation and technological development unfolds. Moreover, most innovation agencies recognize the global character of innovation value chains and build their outposts in "innovation hotspots" abroad, including in Silicon Valley (e.g., Innovation Norway, Vinnova, POLSKA Silicon Valley Acceleration Center, etc.), Shanghai (Innovation Center Denmark, Tekes), and other locations where they can best support information and business flows with their home countries.

Yet despite the wide variety of these approaches, it is possible to group national innovation foundations by their operational missions and goals—a critical first step toward assessing the different models in the field (the focus of this report). Ultimately, this should lead to a practical comparison of effectiveness and evaluation of best practices.

Country	National Innovation Agency/Foundation	Year Founded
Chile	National Innovation Council for Competitiveness	2005
China	Ministry of Science and Technology	1998
Croatia	The Business Innovation Croatian Agency	1998
Czech Republic	The Technology Agency of the Czech Republic	2009
Denmark	Danish Agency for Science, Technology, and Innovation	2006
Finland	Tekes and SITRA	1983
Hungary	National Innovation Office	2010
India	National Innovation Foundation	2000
Ireland	Forfas	1994
Japan	New Energy and Industrial Technology Development Organization (NEDO)	1980
Lithuania	Agency for Science, Innovation and Technology	2010
Kenya	The Kenya National Innovation Agency	2013
Korea	Korea Industrial Technology Foundation	2001
Malaysia	Agensi Inovasi Malaysia	2010
The Netherlands	SenterNovem	2004
New Zealand	Ministry of Business, Innovation, and Employment	2012
Norway	Innovasjon Norge	2004
Peru	National Council for Science, Technology and Technological Innovation (CONCYTEC)	2004
Poland	National Centre for Research and Development	2007
Portugal	Portuguese Agency for Competitiveness and Innovation	1975
Romania	Executive Agency for Higher Education, Research, Development and Innovation Funding (UEFISCDI)	2010
Slovenia	SPIRIT Slovenia—Public Agency of the Republic of Slovenia for the Promotion of Entrepreneurship, Innovation, Development, Investment and Tourism	2013
Slovak Republic	Slovak Innovation and Energy Agency	2007

Spain	Ministry of Science and Innovation - Centre for the Development of Industrial Technology (CDTI)	1977
South Africa	National Advisory Council on Innovation	2006
Sweden	VINNOVA	2001
Taiwan	Industrial Technology Research Institute	1973
Thailand	National Innovation Agency	2003
United Kingdom	Department of Business, Innovation, and Skills	2009
Uruguay	National Research and Innovation Agency (ANII)	2008

Table 1: Selected Countries Fielding a National Innovation Agency or Foundation[3]

This effort has more than academic merit; national innovation entities may wish to improve their own performance based on the best practices of their peers (particularly in times of austerity, with the attendant budgetary threats), while nations without well-developed innovation foundations or agencies (including the United States) may wish to close the gap with their competitors based on established best practices (as the Information Technology and Innovation Foundation and Brookings Institution argue in *Boosting Productivity, Innovation, and Growth through a National Innovation Foundation*).[4] Innovation is cumulative and collaborative, but it is also competitive; countries that ignore avenues of advance in the innovation race do so at their peril.

In outlining the various functions of a national innovation agency or foundation, it is important to draw a distinction between national innovation entities (NIEs, for the purpose of this discussion), and national science foundations. Due to the fact that NIEs tend to deal substantially with research in science and technology (the basis of so many innovative products and practices), it would be understandable to conflate them with science foundations. The principle difference is that science foundations support scientific research for the sake of advancing knowledge and understanding; NIEs are more market-oriented, supporting research with a specific and practical eye toward a commercially viable result. They seek to enhance the innovative capacity of private sector organizations or government agencies.

The missions and operations of NIEs tend to cover one or more of four distinct fields:

Policy: Innovation policy touches an almost bewildering variety of disciplines, including education, transportation, taxation, communications, defense, and immigration (to name but a few), as all have a direct and significant impact on the development of an innovative economy. Most NIEs at least offer analysis and critique about how proposed government initiatives will affect their country's innovation competitiveness, while many generate their own policy recommendations and advocate for them, essentially operating as think tanks. For example, the South African National Advisory Council on Innovation takes this role as its sole mandate, evaluating its success based on the number and scale of its policy

interventions. Promoting innovation throughout a government's administrative agencies is also a core goal of most countries' NIEs.

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SME Investment: A critical challenge for the innovation economy is capital access for tech-based (or other innovative) start-ups or small-to-medium-sized enterprises (SMEs). While the market fills some of this need, a number of NIEs supplant a shortfall with regard to innovative SMEs' access to capital by getting directly involved in early-stage investment. This generally involves some degree of connecting young firms with established pools of capital, but many NIEs maintain their own investment funds specifically designed to support innovative small firms. These can be entirely independent (as with NESTA and TEKES), or a segment of a broader budget to support small businesses (as with France's OSEO or venture capital financing and co-investment by Poland's NCBR).

Research: Innovation is not exclusively about technology (a new management or marketing technique can certainly qualify), but most new products or services have their origin in some aspect of scientific or technical research. NIEs support this (again, with an eye toward a commercial outcome) via grants to researchers, or in some cases by engaging in research directly, as with Japan's NEDO. NIEs also support original research into innovation methods, techniques, strategies, and new business model development. On the research front, another core function of most NIEs is measuring the locus, extent, and effectiveness of innovative activity within a country's enterprises and industries.

Network Development & Management: The innovation infrastructure includes a number of resources—private capital, small firms, universities and researchers, communications and transportation specialists, and many aspects of government—that generally operate in isolation, or very limited association, but have significant power when coordinated. Most NIEs, such as Spain's CDTI, have some aspect of building and coordinating this network of resources in their portfolio, from introducing SMEs to investors or new markets, to assisting researchers, capital investors, and private firms with successful technology transfer. Moreover, many European agencies using Structural Funds have invested heavily in the development of infrastructure and networks of incubators, accelerators and business angels.

This paper examines the charter and operations of national innovation foundations in five countries—Uruguay, Taiwan, Switzerland, Finland, and Poland—nations chosen for the illustrative and disparate nature of their innovation entities.

URUGUAY

In 2007, Uruguay launched its own national innovation foundation, the National Research & Innovation Foundation (ANII). Uruguay created this new, innovation-focused institution because it recognized that "there is no development without innovation."[5] Or, as one commentator put it, "Today, Uruguay's economic policies gear around innovation." Uruguay recognizes it must become a "learning society" with "an economy based on knowledge and powered by innovation."

ANII has a staff of 53 in Montevideo, which operated with an initial budget of $120 million from 2008 to 2012. Today, ANII operates with an annual budget of $35 million. ANII's funding comes both from the Uruguayan government and from external donors

such as the World Bank, the Inter-American Development Bank (IADB), and the European Union. ANII supports innovation efforts targeting key Uruguayan industries, including the country's agriculture, energy, and health sectors, and seeks to directly connect Uruguay's science, technology, and innovation policy with social, environmental, and macroeconomic goals. ANII's "main objectives include the design, organization, and administration of plans, programs, and instruments oriented toward scientific-technological development, as well as the reinforcement and deployment of innovation capabilities."

Uruguay created its new, innovation-focused institution because it recognized "there is no development without innovation."

Institutionally, ANII does not define Uruguay's R&D and innovation policies, but orchestrates and implements direction provided by an "interministerial cabinet of innovation" that includes eight cabinet-level ministries, including the Ministry of Economy and Finances, Ministry of Industry, etc. The National Research and Innovation Foundation is conceived of as a relatively small institution, operating agile, open and transparent mechanisms for allocating resources and systematic procedures for internal and external evaluation.

Uruguay decided to create ANII in response to several specific challenges. First, Uruguay faced low demand for innovation from companies, with its innovative enterprises confined primarily to those in the export sector, and even then innovative activities in those enterprises were limited to the incorporation of capital goods. Another challenge pertained to raising the R&D intensity (R&D investment as a share of GDP) of the Uruguayan economy, which in 2014 was less than 0.4 percent. Moreover, there was little strategic focus on federal R&D investment; the research agenda was not focused on specific economic, industry, or social challenges but was basically defined by individual researchers. Thus, ANII plays an important role in redesigning Uruguay's national innovation system and in better ensuring that the country's R&D investments contribute to improved social and economic outcomes.

Since its founding in 2007, ANII's largest initiatives have been developing a national system of research and innovation for Uruguay (for which it received a $26 million grant from the World Bank) and launching a Technological Development Program (for which it received a $34 million contribution from IADB). ANII supports innovation through a number of instruments. Several of the most important are its support for high-impact, technology-based projects, support to innovative enterprises, support for public-private innovation consortiums, and development of technological, sectoral, and regional innovation networks. For example, ANII supports both enterprises' specific innovation efforts and also the strengthening of enterprises' innovation capacities by providing non-refundable co-financing of selected innovation projects that increase the competitiveness, productivity, or profits of enterprises. In exceptional cases, ANII provides seed capital to innovative new enterprises whose products or services can be "interwoven into different experiences at a national level." ANII sees this as "subsidies to share innovation risk in enterprise and to increase competitiveness." Other core activities include fostering enterprises' R&D capabilities, in part by supporting human resources training, and supporting coordination between academe and industry toward innovation activities.

ANII further collects data on Uruguayan innovation intensity, conducting surveys of innovation activities in Uruguayan services and manufacturing industries.

As ANII has only been in service for eight years, a formal institutional evaluation of the program's success has yet to be undertaken. However, the World Bank has attributed Uruguay's economic recovery in the latter half of the 2000s and early 2010s in large part to the country's innovation policies.[6]

TAIWAN

Founded in 1973, Taiwan's Industrial Technology Research Institute (ITRI) is a nonprofit research and development institute that conducts R&D in applied technologies to advance private-sector growth. Over the past three decades, ITRI has helped Taiwan establish innovative science and technology industries, assisted traditional industries in technology upgrading, provided training for industrial technology talent, and blazed trails for many advanced and critical industries along Taiwan's journey of industrial development. ITRI has played an instrumental role in transforming Taiwan from a labor-intensive to high-tech economy and building Taiwan's international economic competitiveness. Many of Taiwan's most successful high-tech companies, including the semiconductor titans Taiwan Semiconductor Manufacturing Corporation (TSMC) and United Microelectronics Corporation (UMC), can trace their origins to ITRI.[7]

ITRI has 5,728 personnel, 75 percent of whom hold master's or doctorate degrees. ITRI focuses on six core technology areas: Information and Communications Technology (ICT); Electronics and Optoelectronics; Materials, Chemicals, and Nanotechnology; Biomedical and Medical Devices; Mechanical and Systems; and Green Energy and Environment. ITRI personnel have played an important role in the development of countless next-generation technologies, including WIMAX wireless broadband, solar cells, radio frequency identification technology (RFID), light electric vehicles, flexible displays, 3-D ICTs, and telecare technologies. Several ITRI labs, including the Flexible Electronics Pilot Lab and the Nanotechnology Lab, provide international-level research platforms where R&D can be conducted jointly with global partners. ITRI also focuses on service innovation—in particular, leveraging ICTs to bolster the competitiveness of Taiwan's services industries.

ITRI focuses heavily on the development of applied technologies that can bolster the competitiveness of Taiwan's increasingly technology-based economy. ITRI holds more than 14,571 patents and its personnel produce an average of five new patents *every day*. In 2010, ITRI filed 2,004 national and international patent applications, of which 1,368 were approved, 940 of those in foreign countries. In fact, ITRI ranked number 53 in terms of entities receiving U.S. patent grants in 2009 and was the leading patent applicant in China from 2008 to 2009, applying for 490 patents.[8]

But for ITRI, it's not just about creating new technology; it's about taking that technology and spinning it off into viable enterprises. Thus, ITRI has cultivated 70 CEOs and assisted in the creation of over 165 start-up and spinoff companies.[9] In other words, ITRI is both about directly creating new technology and about directly creating innovative new companies. But ITRI also works with existing companies/industries to assist them in

technological research or technological upgrading projects. In 2010, ITRI completed 15,139 such "industrial services" cases, with SMEs accounting for 74 percent of firms assisted and larger enterprises 26 percent. ITRI further provided support to 1,189 RD&I (research, development, and innovation) projects at Taiwanese firms in 2010, with the contribution totaling NT$28.5 billion ($951 million). Of this, 28 percent of the RD&I projects ITRI supported were in the ICT sector; 24 percent in Mechanical & Systems; 17 percent in Energy and Environment; 15 percent in Materials, Chemicals, and Nanotechnology; 9 percent in Biomedical & Medical Devices; and 8 percent in Electronics and Optoelectronics.

It's ironic that the United States understood the importance of bolstering the innovation potential of an ally, Taiwan, in the Cold War through helping it set up an innovation foundation, but it still hasn't created a similar entity for itself.

Taiwan's experience shows that government support can be crucial in helping a country achieve rapid technological catch up. ITRI was founded under the direction of Minister of Economic Affairs Sun Yun-suan and the leadership of its first president, Chao Chen Wang. A driving motivation was to transform Taiwan's existing export industries—which were developed in the 1960s and centered on textiles, shoes, plastic toys, and agriculture—to the more sustainable fields of petrochemicals, machine tools, and electronics. ITRI has played a key role in facilitating synergy and linkage among government, industry, and universities and thus played a pivotal role in the successful commercialization of innovative products and services. ITRI has also helped SMEs absorb and assimilate existing technologies that they cannot invest in by themselves.

Put simply, ITRI proved instrumental in creating the semiconductor and electronics industry in Taiwan. United Microelectronics Corporation (UMC), spun off from the ERSO division of ITRI, was launched in 1980 in Hsinchu Science Park. It was Taiwan's first mainstream semiconductor company. UMC was followed by TSMC in 1986, the Taiwan Mask Corporation in 1988, and the Vanguard International Semiconductor Corporation in 1994. TSMC's first semiconductor wafer fabrication plant was set up on the ITRI campus in 1985.

Metrics and measures ITRI uses to evaluate its impact include the number of patents granted, licensing income/contracts, the number of spin-off companies, the income generated by industrial and research contract services, and the amount of induced investment through incubation operation.[10]

Finally, it's worth noting that American dollars, through the U.S. Agency for International Development (USAID), were instrumental in the 1960s in launching the China Productivity Center (the precursor to ITRI), whose purpose was to help Taiwanese manufacturers become more productive—and thus compete better with U.S. manufacturers.[11] It's ironic that the United States understood the importance of bolstering the innovation potential of an ally in the Cold War through helping it set up an innovation foundation, but it still hasn't created a similar entity for itself.

SWITZERLAND

Dating back to 1943, the Commission for Technology and Innovation (CTI), an independent agency within the Federal Administration, serves as Switzerland's innovation promotion agency. CTI's core mission is "getting science to market," a goal it achieves

through three principle activities: 1) supporting market-oriented R&D, in which companies pursue joint projects in collaboration with universities; 2) supporting the creation, incubation, and development of start-up companies by providing education, training, coaching, and access to financing; and 3) promoting knowledge and technology transfer (KTT) through regional networks. CTI seeks to sponsor joint innovation projects that can address a market need, achieve economic success, and/or bring added value to society.[12]

Switzerland's innovation promotion agency, CTI, follows the subsidiarity principle, meaning that virtually all projects involve collaborative efforts between universities and companies.

CTI's staff of 135, half of whom focus on assessing/guiding innovation projects and half of whom focus on coaching start-up firms, are located across CTI's three divisions. The R&D Project Promotion Division helps bring innovations to market by contributing funding to R&D projects. The division focuses on four areas of scientific R&D project promotion: Life Sciences, including Biotech and Medtech (which accounted for 22 percent of funded R&D projects in 2011); Enabling Sciences (32 percent); Micro- and nanotechnologies (17 percent); and Engineering Sciences (29 percent). The Start-up and Entrepreneurship Division both supports innovative SMEs and seeks to make scientists more aware of the possibilities of entrepreneurship. The KTT Support Division encourages the mutual transfer of knowledge and technology between higher education institutions and companies wishing to pursue innovation projects. In 2011, CTI received CHF 110.8 million ($113 million) in baseline funding and an additional CHF 114.5 million ($117 million) in special support funding (a supplemental appropriation provided because of the rapid appreciation of the Swiss franc in recent years) which supported a total of 556 research projects.[13] Over 70 percent of the approved projects were advanced by Swiss SMEs.

While CTI's goal is to support firm-level innovation, it does not do so by making direct investments in companies; rather CTI funding flows exclusively to eligible research institutes in Switzerland that partner with companies on RD&I projects. Known as the subsidiarity principle, it means that virtually all the R&D projects CTI supports involve collaborative efforts between universities and companies. Moreover, implementation partners (e.g., companies) must contribute at least half the funding on all R&D projects. As such, of the 556 projects CTI supported in 2011, 42 percent of total project funding came from CTI and the remainder was provided by industry. CTI funding is provided based on a bottom-up approach; that is, competition-driven evaluation of R&D proposals undertaken by enterprises and universities. CTI also works to promote international innovation partnerships and forge international connections for Swiss innovators.

As with Finland's Tekes, Switzerland's CTI is particularly focused on bolstering the innovation capacity of SMEs, which account for 99.7 percent of all Swiss firms and 67.5 percent of Swiss employment. As Figure 1 shows, CTI's programs address the four key challenges that start-ups face in crossing the "Valley of Death"—financing, seed money, know-how, and networking.

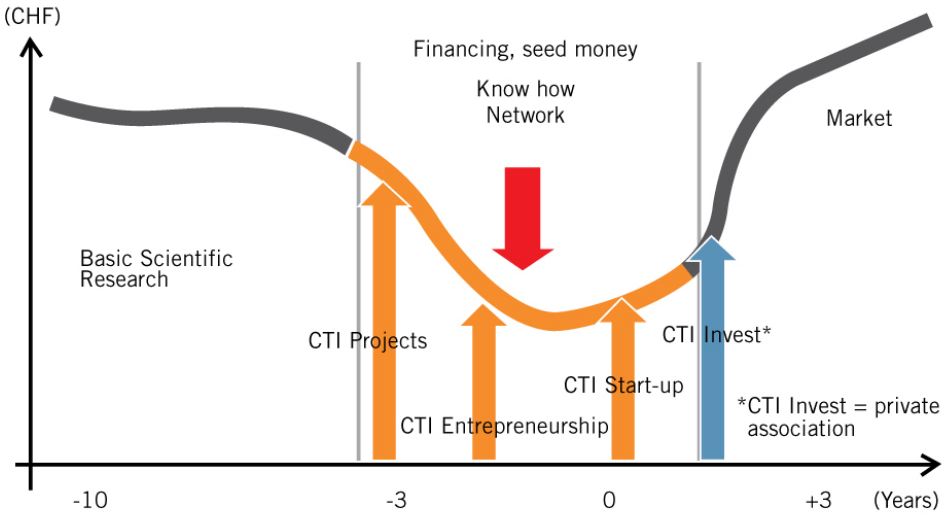

Figure 1: CTI Start-up Addresses Four Key Challenges Facing Start-ups[14]

CTI's "CTI Start-up Programme" helps entrepreneurs to realize their innovative idea professionally. As part of the service, a business expert evaluates the entrepreneur's business model (based on criteria such as technology, market size, management quality, etc.) and if the business concept "passes inspection," CTI helps the entrepreneur craft a detailed business plan and strategy.[15] Since 1996, CTI Start-up has reviewed more than 1,800 projects and awarded over 200 start-up enterprises the coveted *CTI Start-up* label (awarded to select companies upon completion of the CTI Start-up coaching process). For young start-ups, this is a major step toward success: the label confirms that the company's market prospects are good and that the company is a strong candidate for venture capital funding.[16] The "CTI Invest" program supports Swiss high-tech companies that are looking for investors and that can participate in the CTI start-up coaching process. Another instrument CTI uses to support innovative, high-potential SMEs is the "innovation cheque," which allows SMEs to apply for a €5,000 voucher they can redeem at universities or research institutions for assistance with technology feasibility studies, technology transfer, or in developing new technology.

CTI's Entrepreneurship Programme assists university graduates and professionals with novel business ideals and gives them coaching and training advice on how to create a company. CTI's "Venture Kick" program invites researchers to start their own businesses by financing the rapid development of product ideas that stem from their research projects.

CTI also encourages knowledge and technology transfer. Its "KTT Consortia" program focuses on intensifying collaboration between firms and universities at the regional level, enhancing the ability of firms to express specific needs for scientific knowledge (promotion of the pull process in KTT), building up regional KTT service centers as contact points for firms and universities, and providing better matching knowledge for firms (especially SMEs) and universities in innovation activities. CTI provides matching funding for four regional KTT consortia.

Just like many other countries, Switzerland has made a firm commitment to innovation-based economic growth. It has not only maintained but even extended these investments despite the difficult economy wrought by the Great Recession. For example, Switzerland's response to the economic crisis of 2009 was to expand the country's investments in science, technology, and innovation, as the Swiss parliament increased R&D funding levels and launched the innovation cheque program to support innovation in small businesses.[17] These efforts have paid off: as the *Innovation Union Scoreboard 2011* notes, "Switzerland is the overall Innovation leader, continuously outperforming all EU27 countries."[18]

Of particular note is the impressive survival rate among innovative SMEs that CTI has supported. Of the 269 companies awarded the coveted *CTI Start-up* label since 1996, 86 percent (231) survive today. Those companies have created over 3,700 jobs. While Switzerland boasts one of the strongest national innovation systems in Europe, as it looks to the future it sees several areas in which it can boost its performance, including addressing a lack of engineers, weakness in service innovation, cultural weakness in entrepreneurship, and a lack of absorptive capacity of SMEs.[19]

FINLAND

Founded in 1983, Tekes, Finland's Funding Agency for Technology and Innovation, is among the world's leading innovation agencies and has been a key contributor to Finland becoming an international leader in the field of science and innovation policy over the past 15 years, as reflected in innovation indices such as the *European Innovation Scoreboard* and ITIF's *The Atlantic Century I* and *II* reports.[20] As an agency situated within the Finnish Ministry of Employment and the Economy, Tekes's mission is to "promote the development of Finnish industry and services by means of technology and innovation" with the goal of renewing industries, increasing-value added and productivity, boosting exports, generating employment, and promoting well-being.

Tekes primarily funds three distinct sets of leading-edge research, development, and innovation projects: those taking place at innovative, high-growth-potential young firms, at established companies, and those (often collaborative RD&I projects) taking place at universities or research institutes. Tekes has six core research focus areas: 1) natural resources and sustainable economy; 2) vitality of people; 3) intelligent environments; 4) business in global value networks; 5) value creation based on service solutions and intangible assets; and 6) renewing service and production by digital means. In addition, Tekes has been a key driver of services innovation research, promoting innovation in public sector procurement, the use of innovative practices throughout government, and user-driven and demand-led innovation principles.

Tekes's 294 employees worked from a 2011 budget totaling €610 million ($754 million), of which €349 million ($431 million) was invested in supporting enterprises' RD&I projects, and €251 million ($310 million) supported RD&I projects carried out by universities, research institutes, or polytechnics.[21] Tekes's activities are overwhelmingly directed at smaller firms, with 60 percent of funding directed to SMEs (firms with less than 250 employees), 73 percent directed to firms with fewer than 500 employees, and 27 percent (€94 million; $116 million) directed to larger enterprises. Tekes's €610 million of

funding in 2011 supported the completion of 1,550 RD&I projects, with 470 (30 percent) related to new or improved products, 396 (25 percent) to new or improved services, 279 (18 percent) to new or improved processes, and 840 to patent applications.

Tekes provides risk funding for R&D and innovation activities, placing particular priority on supporting growth-seeking, innovative SMEs. Tekes is particularly interested in supporting the most challenging projects of "forerunners"—highly innovative, technology-based, high-growth potential SMEs. Tekes also targets SMEs seeking growth through internationalization (promoting the internationalization of Finnish RD&I is a core Tekes goal) and seeks to help SMEs integrate into global value networks. A key reason Tekes is so focused on making robust investments in pioneering, growth-oriented SMEs is because the creation of new growth companies in Finland faces significant market failures in funding, in large part because of the lack of a well-developed venture capital marketplace. Tekes's support for large companies' RD&I projects focuses on competence building and is provided when the new skills or cooperation patterns of RD&I projects significantly impact third-party actors, or when a company is reinventing itself to effect change in its position in the global value network.[22] Tekes's €251 million ($310 million) in funding to universities and research institutions supported 600 research projects in 2011.

Finland's Tekes is among the world's leading innovation agencies and has been a key contributor to the country becoming an international leader in the field of science and innovation policy over the past 15 years.

To facilitate RD&I collaboration between companies, universities, and research organizations, Finland has created Strategic Centers for Science, Technology, and Innovation, or "SHOKs," in which companies and research organizations work in close cooperation to strengthen the competence base and renew different branches of industry. These SHOKs represent new environments for knowledge creation, developing and applying new cooperation, co-creation, and interaction methods that help speed up the innovation process. The SHOKs essentially represent centers of excellence focused on cluster research and industrial R&D activities. There is a SHOK for each of Tekes's six core focus areas, and 20 percent of Tekes's funding is allocated to supporting collaborative research programs at the SHOKs.[23] A January 2013 report, *License to SHOK,* evaluated Finland's SHOK program, finding the centers to be "a welcome promoter of industry-driven research [that have] defined their own research agendas and produced new instruments for innovation and research policy." It also noted, however, that the SHOKs needed to better balance "the tensions between the short-term interests of industry and the longer-term perspective required in the promotion of cutting edge or 'breakthrough' scientific research."[24]

During its history, Tekes's focus has gradually shifted from R&D cooperation to technology policy to innovation policy, and accordingly its activities have evolved much more into supporting private-sector innovation.[25] As evidence of this, research programs at the SHOKs are now chosen by industry, the Tekes board now features more industry representation, and the Tekes director general has a private-sector industrial background.

In 2012, Finland's Ministry of Economy and Employment underwrote a comprehensive evaluation of Tekes, finding the program to have "direct and positive impacts upon innovation activities." And actually, Tekes has achieved quite an impressive track record, both at the industry and firm level. It has activated firms to increase R&D; enabled the

creation and use of new knowledge and technologies; helped distribute the technological, business, and financial risk of R&D projects; and extended the size, scope, and duration of RD&I projects. Tekes funding has triggered innovations that increase the rate of growth, supported the globalization of Finnish industry, and helped commercialize new products, services, and business processes. Tekes has played a key role in the longer-term development of several industries (including the forest, ICT, and services industries), and proven instrumental in establishing new fields—such as biomaterials—in Finland.

Tekes's impact has been particularly pronounced at the firm level. In fact, one study found that Tekes has participated in the funding of 60 percent of Finnish innovations, with Tekes playing a significant role as a funder, activator, networker, or investor in 80 percent of those cases.[26] Another study found that Tekes funding significantly aided 51 percent of Finnish innovations recorded from 1985 to 2007, and that Tekes's share of involvement in large companies introducing radical innovations reached 71 percent in 2008.[27] And while Finland doesn't pick "national champion winners," effective public-private partnerships have played an indispensable role in supporting the incubation and growth of innovative Finnish firms. Indeed, the total share of high-growth companies in Finland that have received some form of public aid is 76 percent; Tekes supported approximately one-third of these firms.[28] Two-thirds of companies believe Tekes funding has contributed to increased net sales. Finally, Tekes funding has clearly contributed to "input additionality," meaning that companies performing Tekes-funded R&D invest more of their own money in R&D than those without Tekes funding. While Tekes must continue to adapt along with the changing challenges facing the Finnish economy, Tekes's contributions have clearly been instrumental to the flourishing of Finland's innovation-based economy.

POLAND

The Polish National Innovation System is a rather recent one, formed in particular within the past few years, when a new institutional arrangement was needed to distribute EU Structural Funds dedicated for research and innovation. The system includes the National Center for Research and Development (NCBR), reporting to the Ministry of Science and Higher Education; the Polish Agency for Enterprise Development (PARP), reporting to the Ministry of Economy; Polish Universities, Research Centers and Technology Parks; Technology Commercialization Centers, Incubators, Accelerators, Business Support Organizations; and financial entities, such as venture capital funds, business angels networks, etc.

The key institution in the National Innovation System of Poland is NCBR—the executive agency of the Ministry of Science and Higher Education, in charge of implementing policies in the area of national science, technology, and innovation. NCBR was established in 2007 and has approximately 350 staff members. Since 2011, the center has become one of the key institutions implementing EU-funded measures within the Operational Program Innovative Economy (OPIE). It handled the grants distributed to research entities and innovative firms under two priorities: 1) research and development of new technologies, and 2) R&D infrastructure. The center disposed altogether of €4.1 billion ($4.52 billion) of EU funds in the 2007-2013 programs.[29]

Poland has formed its national innovation system over the past several years with goals including bolstering university quality and commercialization activity and stimulating private-sector innovation.

NCBR has integrated the EU-funded programs into the broader framework of its activities, including contributing to science and technology policy and funding measures for risky ventures. As the implementing agency, NCBR integrates within its programs the priorities of the National Research Plan and the Smart Specialization Strategy to ensure growing consistency between emerging scientific and industrial specializations. On the SME funding front, NCBR has been especially active through programs designed to channel money into venture capital funds and to stimulate the launch of projects commercializing technology. The major program undertaken in conjunction with VC funds is BRIdge VC, for which NCBR will bring zł110 million ($29 million) of funding to the table, expecting zł100 million ($26.6 billion) input from the venture funds. NCBR also runs sectoral programs, such as the shale gas program, social innovation program, and applied research program.[30] It also runs a program supporting Polish innovative firms that expand in Silicon Valley: Go_Global.pl.[31] In order to drive research in areas defined as strategically important, NCBR runs programs such as BIOSTRATEG, funding research in the environment, forestry, and agriculture, and STRATEGMED, funding research in lifestyle diseases. According to an interview with World Bank experts on innovation policy, the employees of NCBR followed trainings developed by World Bank staff, ensuring the programs designed by the organization match the highest standards available within innovation policy practice.

The Ministry of Science and Higher Education is the key partner for NCBR in the area of strategic innovation policy planning in Poland. As the body responsible for higher education institutions across the country, including universities and research centers, it originally focused more on purely scientific programs and research grants. The ministry is the institution involved most closely in the drafting of a National Research Plan (one of the bases for the Smart Specialization scheme). It also provides the link between NCBR and universities.

In the area of SME funding, the work in Poland is divided between NCBR and other key institutions, namely the Ministry of Economy and Polish Agency for Enterprise Development (PARP). The ministry oversees strategic policymaking on the business side of innovation, whereas PARP is the agency managing EU-funded programs devoted to enterprise development. Between 2007 and 2013, PARP managed a number of funding measures designed to support access to risk finance for SMEs and technology upgrading of firms. Grants were distributed directly to innovative firms, to partner organizations launching incubators, to venture capital firms, and to business angel networks through competitive calls. In some cases, for instance for measures 1.4 and 4.1 of OPIE, the funding programs were managed jointly by NCBR and PARP, to ensure smooth transition from the prototyping stage to commercialization. The Ministry of Economy is also the institution in charge of the Smart Specialization strategy launched at the EU level. The smart specializations devised on the basis of current sectoral achievements of science and industry will serve as guidance for regional development and for distribution of EU funds from the upcoming programs, including Operational Program Smart Development, 2014-2020.

Weresa classifies Poland as a "catching-up National Innovation System."[32] She underlines Poland's strength in terms of financing for education, yielding Poland's competitive strength in human capital. However, alongside many experts, she also points out that resources devoted to innovativeness are very low in Poland and that within the system there are organizational issues that may only be addressed through systemic solutions. Poland suffers from a rather poor environment for business, ranking only 45 in the World Bank's *Doing Business* rankings.[33] While the Polish workforce is generally well-educated, the scientific excellence of Polish universities tends not to be very well evaluated—only six Polish universities are ranked in the QS World University Rankings, with University of Warsaw ranked 338 and Jagiellonian University ranked 376. Many researchers, including Hausner et al. and Rybiński see the need for more strategically oriented innovation policy in Poland, with a better use of the EU funds, distributed through more flexible and less bureaucratic programs.[34]

CONCLUSION

Countries' innovation foundations differ significantly in scale, and their size does not always correspond to that of the economy of their country; but where they are fundamentally similar is in a common, if not ubiquitous, set of goals—policy, SME support, research, and network development/management—and in the fact that most are at least 10 years old.

The significance of this will not be lost on anyone who has dealt with government appropriations or investment. Many of these organizations may be young, but it is not too early to start asking if they have begun to earn back the initial investments that founded them. Some countries have already commissioned evaluations of their innovation entities, as in the case of Sweden and Finland noted above; others are moving in that direction. The European Commission has also recognized the importance of peer exchange of best practices, with the past European Research Area Committee (ERAC) Peer Reviews (for instance for Denmark and Spain) and the new Policy Support Facility enabling easier conduct of further peer reviews of innovation systems and mutual learning between EU member states on best practices in innovation policy.[35] The Great Recession and its financial effects, particularly the imposition of austerity programs, create an added impetus for evaluation of return on investment, and, with or without an official evaluation, place innovation entities at particular risk; NESTA, the UK's innovation foundation, had to engage in some deft maneuvering after the British general election of 2010 to avoid being part of the so-called "bonfire of the QUANGOS" (quasi-autonomous non-governmental organizations), despite its independent budget and character (it is now a wholly independent charity).

Finland's Tekes may prove to be an exceptional innovation entity; it may also prove to be exemplary in the fullest sense of the word. If the younger generation of innovation entities delivers returns on the same order as Tekes, the question for governments with such organizations (and, much more sharply, for governments without) is not whether they can afford to preserve and support an innovation entity—it is whether they can afford not to do so.

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