Sri Lanka
State of the Economy Report 2012

Chapter 7
Stimulating Innovation for Sustained High Growth

by
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7. Stimulating Innovation for Sustained High Growth

"Innovative entrepreneurs, with their new products, new processes, new markets, and novel approaches to putting inventions to effective use, are key to an economy's long-term growth"

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7.1 Introduction

In positioning Sri Lanka for an era of faster growth, it is rightly acknowledged that "successful integration with the global economy and its sustained success in international competition will depend increasingly on effective combinations of science, technology and innovation."[1] Towards this end, there is also recognition of the fact that the country needs capacity in research and innovation, especially in view of attempts to position Sri Lanka as a 'knowledge hub' under the current policy framework. Creating supporting structures which ensure that goods and services produced in the country are globally competitive, therefore, becomes essential. This depends mainly on enhancing the level of innovation of the Sri Lankan economy.

> ***"Making innovation policy a key priority will determine how Sri Lanka country places itself in a rapidly changing global economic environment, delivering high growth and prosperity for its people"***

In the policy document "Sri Lanka: Emerging Wonder of Asia," the term 'innovation' features forty times, attesting to the emphasis placed on its importance. Yet, on each occasion it refers to innovation in particular sectors and the 'need' for promotion thereof. Taking a holistic approach, driving innovation at a national, strategic level, therefore, needs to become the new priority. Although technology has permeated many levels of the economy and society in the country, Sri Lanka has missed successive 'waves' of transformative technology, partly due to the distrac-

[1] Ministry of Finance and Planning (2010), *Sri Lanka: The Emerging Wonder of Asia*, pp.126.

tion of its long conflict. The UK, Europe and the US advanced on the basis of the industrial revolution. South Korea, Taiwan, and other East Asian 'tiger' economies latched on to the ICT and electronics (semi-conductor) revolution. China, India and Cuba caught the bio-technology revolution.

Sri Lanka ranks poorly in the Global Innovation Index, at 82nd out of 115 economies ranked, but does show promise on several sub-indicators analyzed in the report. The challenge now is to see which elements of these technology revolutions can still be adopted in the country to drive higher value exports and greater domestic value addition of products, while improving the standard of living of the people. Meanwhile, latching on to new and emerging technological revolutions like nanotechnology, which can be truly transformational, must also be looked at.

The overarching issue for all of this is the need to create a dynamic innovation culture in the country, and for this, having a holistic innovation policy is essential. While neither national governments, public institutions, or even firms, can fully predict what the next technology revolution would be or forecast how best to latch on to it; by creating a culture where innovation thrives and permeates through the majority of the economy, economic actors in the country would be able to be nimble and agile in capitalizing on whatever new technologies emerge and use them to benefit national development and achieve faster economic progress. For this, having the right policy frameworks in place is vital.

Some initiatives in this regard have already been taken. Sri Lanka adopted a Science and Technology Policy (STP) in June 2009. While this identifies the general S&T capability required, and highlights the broad areas of focus, it does not provide specific priorities. Moreover, innovation policy is much sharper than S&T policy. In fact, innovation may not necessarily be achieved through improved S&T capability alone. A more recent initiative towards advancing this agenda has been by the Ministry of Technology and Research which published its 'Science, Technology and Innovation Strategy (2011-2015).' This document takes a far more advanced approach, as well as providing concrete goals and implementation plans; however, it still remains the strategic plan of an individual line ministry. As this Chapter will argue, promoting innovation requires a much more holistic outlook through a national innovation policy that takes a 'whole-of-government approach,' gets the buy-in of a wider array of stakeholders, as well as provides clear direction on what needs to be done by these stakeholders, including line ministries beyond just the Ministry of Technology and Research.

The rest of this Chapter is organized as follows. Section 7.2 will look at the importance of innovation to economic growth, reviewing relevant literature. Section 7.3 attempts to dissect what innovation is and the elements in promoting it. Section 7.4 discusses the importance of innovation policy, while Section 7.5 provides an overview of the status of innovation policy making in Sri Lanka. Section 7.6 introduces the concept of national innovation system (NIS) and how it feeds in to effective innovation policy-making, while Section 7.7 reviews Sri Lanka's performance across selected elements of the NIS (with several sub-sections focusing on particular areas like R&D, human capital, incentives, and financing and commercialization). Section 7.8 highlights the importance of international openness and cooperation to strengthen innovation, while Section 7.9 discusses reversing the 'brain drain' and leveraging the diaspora. Finally, Section 7.10 provides a way forward and concludes.

Box 7.1
Sri Lanka in Bottom Half of Global Innovation Index

Sri Lanka was ranked 82nd out of 125 economies in the Global Innovation Index 2011 issued by INSEAD, an international business school. Sri Lanka stands behind India but ahead of other key South Asian countries. Out of the sub-indices measured, the country is placed at 96 in the innovation input sub-index, which evaluates the environment for innovations, while been placed far above at 65 in the innovation output sub-index, bringing it among the top 20 countries in terms of innovation efficiency. Within innovation inputs; institutions, human capital and research, market sophistication and business sophistication are found to be of relatively low order, while innovation infrastructure seems to be of a higher quality. Within the innovation outputs; Sri Lanka ranks low in science outputs such as patent applications, journal articles, new business density and hi-tech exports, while performing relatively well in creative outputs such as trade mark registrations, recreation and culture, and creative goods exports.

Source: The Global Innovation Index 2011 www.globalinnovationindex.org

7.2 What is Innovation and Why is it Important?

The relationship between economic growth and technological development is well established in the literature.[2] Although not the only pillar of innovation, technological development is both part of the process of innovation as well as a result of it. Innovation involves much more than knowledge of the relevant S&T. At least since Schumpeter (1911), economists have accepted a distinction between the formulation of a working idea for a product or process (an invention) and the application of that idea to the economy (an innovation).[3]

The literature stresses that innovation, i.e., the improvement of existing or the creation of entirely new products, processes, services, and business or organization models, drives long-run economic growth and quality-of-life improvements.[4] The US Department of Commerce has estimated that technological innovation has been responsible for as much as 75 per cent of growth in the US economy since World War II.[5] Innovation achieves this impact by the enabling of productivity and competitiveness improvements that lie at the core of economic growth. For instance, the innovative use of IT was responsible for two-thirds of total factor productivity increase in the US between 1995 and 2002 and virtually all of the growth in labour productivity.[6]

Innovation also leads to job growth. As the Organization for Economic Cooperation and Development (OECD) noted in a review of studies on productivity and employment, "Technology both eliminates jobs and creates jobs. Generally it destroys lower-wage, lower-productivity jobs, while it creates jobs

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[2] For example; Romer, P.M., (1990), "Endogenous Technological Change" *Journal of Political Economy*, Vol. 98. No. 5: Grossman, G. and E. Helpman (1991), *Innovation and Growth in the Global Economy*, MIT Press.

[3] Schumpeter, J.A.,(1911), *The Theory of Economic Development*, Oxford University Press, (1938 edition), as cited in Metcalfe, J.S., (2000), "Science, Technology and Innovation Policy in Developing Economies" a paper presented at a workshop on "Enterprise Competitiveness and Public Policies", Barbados, November 1999.

[4] Ezell and Atkinson (2010), "The Good, The Bad, and The Ugly of Innovation Policy: A Policymaker's Guide to Crafting Effective Innovation Policy", The Information Technology and Innovation Foundation.

[5] Ideas in Action with Jim Glassman (2010), "Is America Suffering an Innovation Gap?", http://www.itif.org /media/america-suffering-innovation-gap.

[6] Robert D. Atkinson and Andrew S. McKay (2007), "Digital Prosperity: Understanding the Economic Benefits of the Information Technology Revolution", Information Technology and Innovation Foundation, http://www.itif.org/files/digital_prosperity.pdf.

that are more productive, higher-skilled and better paid."[7] For a country like Sri Lanka where wages in basic manufacturing are rising (and consequently, the advantage of low-cost labour in the country is declining), and aspirations and attitudes towards employment are evolving towards higher-earning jobs, creating jobs that encourage higher productivity and better skills and pay becomes increasingly important. The OECD report noted that, historically, the income generating effects of new technologies have proven more powerful than the labour-displacing effects: technological progress has been accompanied not only by higher output and productivity, but also by higher overall employment.

Innovation has become a more central driver of growth and competitiveness. As modern technologies have brought the world ever closer together, global economic competition has become more intense than ever. Governments are constantly searching for strategies to win in this global competition to achieve economic growth and prosperity for their people, and attract foreign investment and talent to their shores. In just the past decade, a large number of countries have come to the realization that spurring innovation in the economy must be a central component of their economic development strategies.[8] For example, in 2009, the UK made a conscientious decision to "place innovation at the center of the country's economic growth strategy." Three dozen other countries have now created national innovation agencies and implemented national innovation strategies designed specifically to link science, technology, and innovation with economic growth.[9] An analysis of Eastern European countries found that both innovation-oriented and business-friendly policies enhance national innovation and boosts competitiveness in international markets.[10] The study highlights the crucial role of universities and the existing knowledge base complemented by R&D commitments from both public and private sources in driving innovation.

7.3 Innovation Policy and Key Elements in Promoting Innovation

It is important to understand what constitutes innovation in the developing world. Generally it does not mean something 'new' in absolute terms, but something new for the society under consideration. Innovation is usually instigated by a key actor -- an entrepreneur who brings the project to fruition in designing the new product or process, looking for finance, and exploring markets. The entrepreneur interacts with different organizations within the so-called 'innovation system,' such as universities, public laboratories, banks, business chambers, and other enterprises. In addition, the environment in which innovation takes place is strongly influenced by broader factors such as the macroeconomic situation, the level of infrastructure development, and the quality of institutions and governance.

A key success factor, is to integrate a vision for innovation in to long term development strategies. For example, China decided to become "the world's factory." Malaysia aimed at becoming an "information society world leader." This vision allows a country to define priorities and implement them across ministries and throughout the economy with well-aligned policies and in-

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[7] OECD (1994), "The OECD Jobs Study: Facts, Analysis, Strategy", http://www.oecd.org/dataoecd/42/51/1941679.pdf

[8] Ezell, S.J. and R.D. Atkinson (2010), "The Good, The Bad and The Ugly of Innovation Policy: A Policymakers Guide to Crafting Effective Innovation Policy", The Information Technology and Innovation Foundation.

[9] Stephen Ezell (2009), "America and the World - We're No. 40!", *Democracy: A Journal of Ideas*, Issue 14, Fall 2009.

[10] Krammer, S.M.S., (2009), "Drivers of National Innovation in Transition: Evidence from a Panel of Eastern European Countries", *Research Policy*, Vol. 38, pp 845-860.

vestments. This requires an explicit 'government-wide approach.'

Innovation policy is, therefore, fundamentally different from simply promoting ideas and projects from research to market, or the reverse – identifying needs and calling upon research or the science base to satisfy them. This linear and mechanistic view of the innovation process is outdated; a holistic and biological approach is more appropriate.[11] Governments should see their role as creating a favourable climate in which innovative projects can flourish.

7.4 Government Policy Support for Innovation

In the innovation arena, a government "has basically three functions - providing incentives and facilities to elicit or support innovative projects; removing bureaucratic, regulatory, competitive and other obstacles to innovation; and improving the knowledge base and its use in developing technical education and R&D structures."[12] As explained in Ezell and Atkinson (2010), innovation policy constitutes those elements of science, technology and economic policy that explicitly aim to promote the development, spread, and efficient use of new products, processes, services, and business or organizational models. Innovation policy conscientiously and proactively anticipates and articulates the intersecting roles and relationships of policies in S&T, R&D, education, workforce training, immigration, tax, trade, intellectual property (IP), and digital infrastructure in creating economic and social welfare. An innovation policy should not exhibit favouritism to domestic over foreign firms located in the country or vice-versa; all firms located in the country should be able to enjoy the benefits of the country's innovation policies. In contrast, industrial policy is designed to intervene in an economy to support, favour, or restructure specific business or sectors. Industrial policies often seek to pick specific national champion firms. This was a staple of Japanese and South Korean economic growth policy following World War II.

To clarify the differences between innovation policy and industrial policy, it is useful to envision a continuum of government-market engagement increasing from left to right from a 'laissez faire' approach to 'supporting factor conditions for innovation' to going further by 'supporting key broad technologies/industries' to, at the most extreme, 'picking specific technologies/firms', or in other words, picking winners. As emphasized by Ezell and Atkinson (2010), government support and engagement is best placed at points two and three of this spectrum, supporting factor conditions and placing strategic bets to support potentially breakthrough technologies (e.g., nanotechnology, biotechnology, robotics, etc.) and industries (e.g., broadband telecoms, life sciences, clean energy, etc.), all the while enabling competitive markets. This appears to be the approach taken by Sri Lanka as well, for example, through the general promotion of nanotechnology through the National Nanotechnology Initiative (NNI) since 2006.

The science, technology, and innovation policies of developing economies should not be aimed primarily at reaching the frontiers of world science, technology and innovation. Rather, the central concern should be with the "absorption and adaptation of established practices to suit local resource endowments and market prospects." This is an important consideration for Sri Lanka (Box 7.2).

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[11] Aubert, Jean-Eric (2010), '*Innovation Policy for the Developing World*', Special Report, World Bank Institute.

[12] *Ibid*.

[13] Metcalfe (2000), '*Science, Technology and Innovation Policy in Developing Economies*', paper presented at workshop on Enterprise Competitiveness and Public Policies, Barbados, November 1999.

Box 7.2
Innovation as Adaptation

Innovation as a concept does not simply mean the domestic development of cutting-edge scientific discoveries – for example, Sri Lanka trying to develop a game-changing technology, but also the adaption and use of existing innovations for productive use in the local context. This balance needs to be struck in Sri Lanka. While continuing to drive new innovation, for example, through innovative private-public partnership mechanisms such as the SLINTEC, Sri Lanka needs to cooperate more closely with technology champions in the world – from the world's most innovative nation, the US; or Europe's innovation and technology champion, Germany; to Eastern technology giants like, Japan, China, South Korea and even India.

Many developing countries like Sri Lanka have a long way to go before they can start creating world-changing, cutting-edge technologies. However, this does not mean that their development should not focus on creating an innovation culture. According to the report on 'Building Sri Lanka's Knowledge Economy' published by the World Bank in 2008, large rewards from technology accrue to those that adopt new technologies, adapt them, and make them productive in the local context. A report on Indian innovation revealed that India achieved a five-fold growth in output by simply adopting existing information and technologies elsewhere. East Asian champions like South Korea, Singapore and Malaysia also grew rapidly by adopting existing technologies by often 'looking East,' towards early adopters like Japan. Of course, later, they developed new and advanced capabilities and became global innovation hubs themselves.

Thus, an innovation culture for developing countries like Sri Lanka must be understood as the building of a technical culture and a system of incentives that support the adoption and subsequent adaptation of existing (often foreign) technologies.

Source: Wijesinha, A., (2012), 'What is An Appropriate Path for Sri Lanka as an Emerging Economy?', paper presented at Symposium on E.F. Schumacher Centenary Birth Celebrations, Practical Action, Colombo April 2012

7.5 Status of Policy Relating to Innovation in Sri Lanka

So far, in Sri Lanka, innovation has been seen mainly through the lens of 'science and technology.' In 1998, Sri Lanka established a National Science and Technology Commission as a policy making body with the responsibility of making recommendations on all aspects of scientific and technological development. Prior to this, a Presidential Task Force on S&T Development had published its report in 1991. More recently, however, a Science and Technology Policy was adopted by the Cabinet of Ministers in May 2009 (see Box 7.3).

The more recent government vision and policy document, "Sri Lanka: Emerging Wonder of Asia," is the main macro-level policy which refers to science, technology and innovation, and it recognizes that a broad range of policy areas need to be considered. It states,

> "Adoption and application of advanced technologies by industries will be promoted. A legislative basis for growth of high-technology industry will be provided through means such as national banking regulations, low-interest loans, tax incentives, and duty-free import of selected capital goods. Support will be given for application of advanced technologies in industry including biotechnology and

Box 7.3
Sri Lanka's National Science and Technology Policy, 2009

Sri Lanka was a latecomer to the S&T game and introduced the STP only in 2009, although attempts to design and adopt a national STP date back to the 1960s. The 10 objectives of the National S&T Policy are:

1. Foster a science, technology and innovation culture that effectively reaches all citizens of the country
2. Enhance science and technology capability for national development, make use of science and technology expertise in the national planning process, and strengthen governance and policy implementation mechanisms
3. Build up, and progressively expand and improve the resource base of scientists and technologists necessary to respond to the developmental needs of the country
4. Promote basic, applied and developmental research, particularly in areas of national importance and priority
5. Develop, or acquire and adapt, scientific knowledge and technologies for transfer, to achieve progressive modernization of all sectors and to enhance the country's competitiveness in the world economy
6. Ensure sustainable use of natural resources for development, while protecting the environment
7. Document, research into the scientific basis of, and promote indigenous knowledge-based technologies
8. Develop a culture of innovation and IP, and ensure the protection of Intellectual Property Rights (IPRs).
9. Ensure quality standards of S&T institutions, products and services to achieve national and international recognition
10. Promote the application of S&T for human welfare, disaster management, adaptation to climate change, law enforcement and defence, to ensure human and national security

The National S&T Policy declares ambitious targets to increase investment for S&T up to 1.5 per cent of GDP by 2016. This value was just 0.17 per cent in 2006 and is in fact the highest allocation in post-independence history (highest being 0.4 per cent in 1975). The target is ambitious even when compared with the globally recommended value for developing countries of 1 per cent.

Source: Witharana, D., (2010), "Innovation Sustainability and Development: A New Manifesto", accessed via http://anewmanifesto.org.

nanotechnology. High-tech industrial parks with requisite modern physical infrastructure facilities will be established" (p.70).

Meanwhile, the Ministry of Technology and Research has under its wing many science and research institutions engaged in R&D and technology development and transfer. Some of these are, the Arthur C. Clark Institute for Modern Technologies (ACCIMT), the National Science Foundation (NSF), and the Industrial Technical Institute (ITI, formerly the CISIR). The ITI, in particular, supports the industry sector though scientific and industrial research and provision of training, consultancy, technology transfer, design, fabrication, calibration, trouble-shooting, and quality assurance services.

7.6 Concept of the National Innovation System

Frameworks aimed at supporting science, technology and innovation have evolved from so-called 'linear' models of innovation into models based on the concept of the NIS. Lin-

ear models imply that there is a direct causal relation from initial impulse to final outcome, which is innovation; the initial impulse can be either of a 'supply push' nature; that is, it originates from government initiatives to set up institutions and policies to encourage R&D, or of a 'demand pull' nature; that is, the initial impulse comes from the demands and needs existing in the markets. Linear models of the 'push' category tends to emphasize supply-side policies (e.g., investment in training, R&D, and national ICT infrastructures), while 'pull' models imply demand-side policies (e.g., market stimulation, user training, or the establishment of uniform standards). In practice, national policies have often been volatile mixtures of technology push and demand pull models, reflected in swings of emphasis between interventionist and laissez-faire policies.

The concept of a NIS is not new to the world, but is still new to developing countries like Sri Lanka. It is largely viewed as a system of interconnected institutions to create, store and transfer the knowledge, skills and artifacts which define new technologies. UNCTAD (2011) notes that, "although there are many definitions of an NIS, in simple terms this concept refers to the network of institutions in the public and private sectors whose activities and interaction initiate, import, modify and diffuse new technologies."[14]

In practice, this is the network of universities, research centres, think tanks, firms, business associations, and more generally, producers and users of knowledge in the country. Meanwhile, supportive government policies are important in fostering NIS. Public policy does have a role to play in cultivating this network. Sri Lanka's recent example of providing tax breaks for private sector firms that utilize public research institutions for their R&D is such an example.

The NIS concept is novel for Sri Lanka, where interaction among various actors and institutions involved in technological innovation remains weak.[15] In this context, it is important to pay attention to how the government policy framework, R&D activities, education system, culture, history, traditions, etc., play their roles in this network system. Developing a robust innovation system in a country requires a robust network, consisting of government institutions, regulators, research institutes, universities, enterprises, consulting firms and professional/business groups. It is not just creating the right environment for this network to operate, but also providing the right government interventions to ensure that a productive nexus develops from this.

A key idea of the NIS perspective is that firms do not engage in innovation in isolation. Innovation depends on the existence of a variety of agents and institutions (much greater in scope than just technology providers and technology users) and on the effectiveness of the interactions between these agencies and institutions. The ability and propensity of an enterprise to innovate not only depends on its access to knowledge from research institutes or technology services centres, but also on many other factors including, access to finance, human resources, adequate basic physical infrastructure, firm-level capabilities (design, operation, maintenance, managerial),[16] in-

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[14] UNCTAD, (2011), Key Aspects of Entrepreneurship and Innovation Policy Framework for Enhancing Local Productive Capacities, UNCTAD.

[15] Wickremasinghe, S. (2006), "National Innovation System: A Way Forward to Stimulate Innovation," *Vidya Newsletter*, Vol.8, No.2, National Science Foundation, Colombo.

[16] Sri Lanka lacks a national institution to help improve firm-level capabilities. Although the National Institute of Business Administration(NIBM) was started with that objective, it has since lost that focus and currently engages almost entirely in running vocational training programmes in business /management, IT, and English, which are perhaps more lucrative.

ter-firm linkages and collaboration partnerships in R&D among academic and commercial entities, general business services, and demand conditions.

Thus, a broad range of matters need to be considered in formulating appropriate policies:[17]

- Increasing the supply of knowledge in the system by reinforcing education, particularly science education, as well as building a deep pool of human capital in scientific research, engineering, managerial, etc. Supply-side policies should be complemented with demand-side incentives.
- Promoting stronger linkages between various players in the national innovation system, for example, by supporting research networks, providing incentives for inter-firm collaboration, and facilitating linkages between public research institutions and private enterprises, as well as between national firms and foreign companies. Policies to encourage public-private partnerships, the development of technology clusters, and the promotion of technology parks are other examples of policies in this broad area.
- Dealing with FPRs may have an important role in facilitating transfer of technology from academia to the productive sector and from international to domestic markets.
- Creating avenues for commercializing and financing innovation, for example by exploring the suitability of venture capital models of some developed countries, as well as fiscal incentives to support innovation.

7.7 National Innovation System in Sri Lanka: Reviewing Performance

While innovation policy discussions, and the NIS, point to a plethora of indicators and areas for consideration, this Chapter limits itself to discussing selected areas when assessing Sri Lanka's performance, owing mainly to data unavailability.

7.7.1 Research and Development

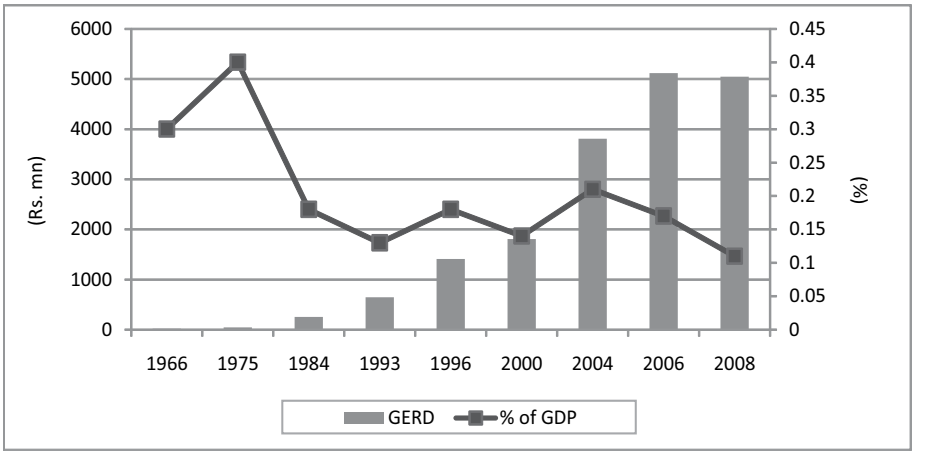
Sri Lanka displays a very low level of national R&D investment as a proportion of GDP - a characteristic that has not changed over time. The number of R&D scientists have also decreased over time. Indeed, the Budget 2012 notes that Sri Lanka's "universities as well as research and technology institutes have around 4,000 researchers at present. This number should be increased to about 20,000 by the year 2020."

Public R&D institutions form the bulk of the NIS in Sri Lanka, along with universities. The National R&D Survey (2008) conducted by the National Science Foundation (NSF) reveals that dedicated R&D institutions account for 29.4 per cent of the total R&D scientists in the country, while universities account for 61 per cent and the private sector around 9.6 per cent. Creating mutual confidence and motivation between the public sector (public research institutions and universities) and the private sector is the need of the hour. It is noted that "R&D scientists (both in universities and research organizations) are distancing themselves from the industry. Unfortunately, most of the industrialists are not fully aware of the potential and capabilities of the scientists at universities and (public) R&D organizations. Such a situation highlights the importance of networking R&D institutions."[18]

[17] Adapted from UNCTAD (2011).

[16] Wickremasinghe, S.I., (2011), "The Status of SMEs in Sri Lanka and Promotion of their Innovation Output: Through Networking of S&T Institutions," *Asia-Pacific Tech Monitor,* Jul-Aug2011, UN-ESCAP Asian and Pacific Centre for Transfer of Technology, pp.17.

Figure 7.1
Gross Expenditure on R&D (1966 – 2008)



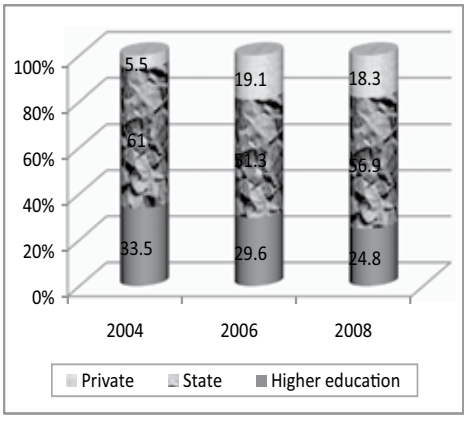
Note: GERD = Gross Expenditure on R&D.
Source: National Science Foundation, Science and Technology Policy Research Division.

Performance on Innovation Inputs

Gross expenditure on R&D has recorded a significant increase over time, particularly after 2000. During the four-year period between 1996 and 2000, the expenditure has marked a growth of 28 per cent, which has increased to 33 per cent between 2004 and 2008 (Figure 7.1).

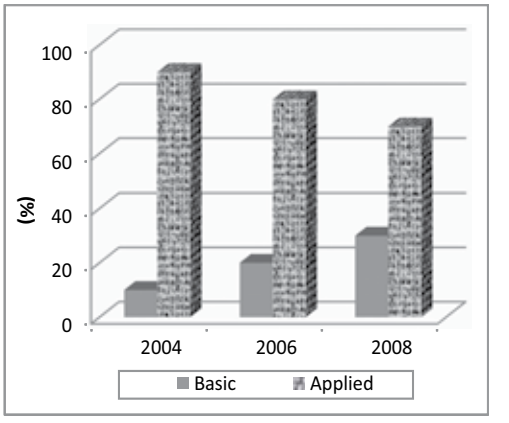
However, the investment on R&D does not seem to have improved proportionate to the growth of national output. The R&D expenditure-to-GDP ratio has declined from 0.4 per cent in 1975 to 0.11 per cent in 2008, recording a diminishing trend over the years.

Figure 7.2
R&D Expenditure by Sector (2004-2008)



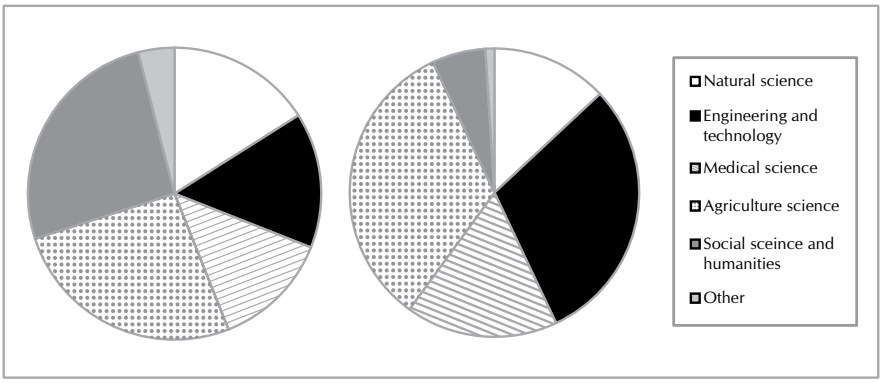
Source: National Science Foundation, *R&D Survey 2008*.

Figure 7.3
R&D Expenditure by Nature of Research Activities



Source: National Science Foundation, *R&D Survey 2008*.

Figure 7.4
Gross Expenditure on R&D by Discipline

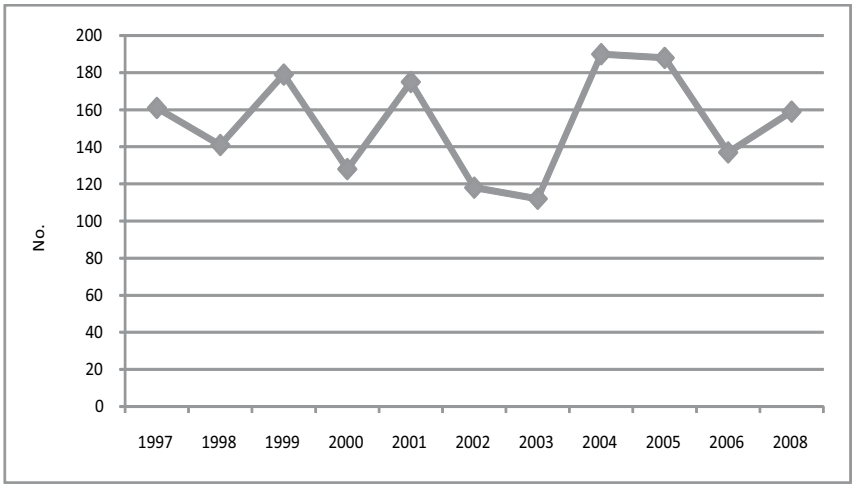


Source: National Science Foundation, *R&D Survey 2008*.

Although the total allocation for R&D has risen over time, the composition by sector shows an interesting trend. The share by higher education and the state sectors have declined over time whereas the reverse has been recorded for the share of the private sector. Out of the total expenditure, the shares for applied research and basic research seem to have moved in opposite directions. The share of allocation for basic research has risen from around 10 per cent to 30 per cent between 2004 and 2008, while that for applied research has fallen from nearly 90 per cent to 70 per cent.

The composition of investment by discipline over the years shows a notable trend. The shares of investment in the fields of natural science and social science have declined, where the latter has marked a significant fall from around 26 per cent to 6 per cent between 2004 and 2008. The remaining three

Figure 7.5
Number of Patents Registered in Sri Lanka (1997-2008)



Source: National Science Foundation, *R&D Survey 2008*.

fields have improved, where the share of expenditure in engineering and technology has doubled.

Meanwhile, the expenditure on R&D by the private sector, out of total R&D expenditure, is low. As Figure 7.2 demonstrates, unlike in most developed countries where much of the R&D expenditure is by the private sector (over 65 per cent in most cases), in Sri Lanka it is a mere 18 per cent. The bulk of R&D expenditure in Sri Lanka is by the state sector (57 per cent). This has strong implications on the rate of commercialization of S&T research.

Performance on Innovation Outputs

The registration of patents in the country has fluctuated over time, resulting in the figures from 1997 and 2008 to be nearly the same. During the 11 years considered, the highest number of patents has been recorded at 190 in 2004, while the lowest has been 112 in 2003.

A significant feature of the trend is that before 2002, the majority of patents have been registered by non-resident scientists, while the pattern has reversed since then. This could be an indication of improved conditions within the country for scientists to carry out research, but more analysis is required before drawing any conclusions.

Dissemination of research carried out by Sri Lankan scientists through publishing in journals has been gradually improving, including the numbers of publications per scientist which has improved marginally over time.

A country's high-tech exports are another significant output measure of the ability to innovate and commercialize their findings effectively. In Sri Lanka, the value of high-tech exports have fluctuated over the years, where it increased from 2002 but drastically declined after 2008, recording over a two-fold drop from US$ 102 million in 2008 to US$ 45 million in 2009, and yet managing to improve by 25 per cent in 2010 (Figure 7.6). The share of high-tech exports out of the total manufactured exports has followed the same trend, recording 2.2 per cent in 2001 and falling to 1 per cent by 2010. The highest high-tech exports in recent years were recorded in 2007 at US$ 108 million while the highest share has been recorded at 2.3 per cent in 2005. While Sri Lanka recorded an average 1.8 per cent of high-tech exports share each year in the last decade, South Korea recorded 75 per cent, Thailand 27 per cent, and Singapore and Malaysia over 50 per cent.[19]

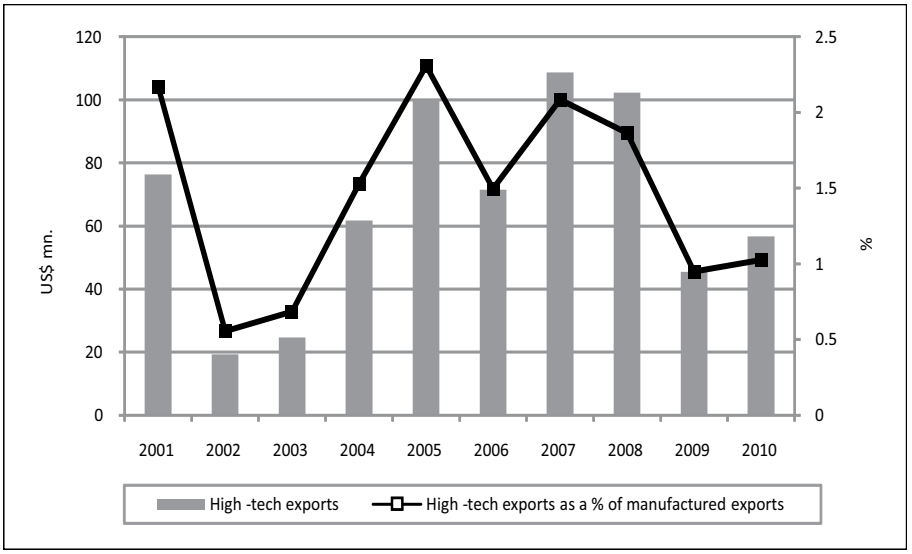
Table 7.1
Publication Trends in Science Citation Index (SCI) Journals by Sri Lankan Scientists

Year	No. of Publications
2004	231
2005	239
2006	233
2007	269
2008	303

Source: National Science Foundation, *R&D Survey 2008*.

[19] *Ministry of Technology and Research, Science, Technology and Innovation Strategy (2011-2015).*

Figure 7.6
Performance of High Technology Exports from Sri Lanka (2001-2010)



Note: High-tech products with high R&D intensity, such as in aerospace, computers, pharmaceuticals, scientific instruments, and electrical machinery

Source: Online World Bank Database, http://data.worldbank.org/.

7.7.2 Moving from Research to Innovation: Industry Linkages, Financing, and Commercialization

As articulated earlier, innovation is distinct from research and does not automatically result from it. The nexus of industry-research collaborations, appropriate financing options, and support for commercialization are vital drivers to move research towards innovation.

Industry-research linkages

Unlike in most developed countries, many universities in developing countries like Sri Lanka have not established sufficiently strong linkages with industry. Such collaborative efforts have become quite pronounced in the developed world, providing benefits to both parties. Industry obtains access to university laboratories, talented research scientists, and a pool of potential recruits. In turn, universities receive industry's financial support, necessary to conduct their work and expand their resources, and they also get feedback from industry to adapt research to the needs of the economy.

The Five Year Strategy of the Ministry of Technology and Research observes that, "at present very few knowledge intensive companies and very little R&D that is required for innovation, is taking place in the private sector. On the other hand, most of the R&D undertaken by Sri Lankan scientists end up as mere publications in scientific journals, with very few research outputs yielding a commercial product or a process. As such, the contribution of R&D to the growth of our GDP at present is negligible." (p. 31)

Currently in Sri Lanka, very few examples of significant industry-research linkages exist. The most prominent one is SLINTEC, which is a first-of-its-kind initiative bringing together leading private sector firms together with leading Sri Lankan nanotechnology scientists. SLINTEC, established in 2008 as a private

company is a Rs. 420 million venture with the shareholding owned by the government (50 per cent) and five private sector founder promoters (50 per cent collectively). The government shares are held through its nominee, NSF, and the five private sector founder promoters are Brandix Lanka Ltd., Dialog Axiata PLC, Hayleys PLC, Loadstar (Pvt.) Ltd., and MAS Capital (Pvt) Ltd. In its first full year of operations alone, SLINTEC was able to secure five international patents on nanotechnology products, including carbon nanotubes, nano fertilizer and nano rubber. This is impressive when compared with Sri Lanka's historic average of 1.8 total international patents per year.[20]

More recently, a leading private enterprise Laugfs Holdings Limited, set up a joint venture with SLINTEC to set up the country's

Box 7.4
Ceramics Council Attempts Research-Industry Collaboration

During 'The Competitiveness Programme' funded by the USAID, the ceramics industry cluster (Ceramics Council) established the Center of Technical Excellence in Ceramics (CENTEC) through a partnership among Sri Lankan ceramic manufacturers, suppliers, the government and universities. CENTEC, opened in 2007, was aimed primarily to be a lab which will investigate ways in which the industry can cut costs, improve production efficiencies and enhance quality of ceramics products.

The Centre, modeled as a PPP, was funded by several ceramics industry firms through both cash contributions as well as donations of equipment. Additionally, the USAID funded a few pieces of expensive testing equipment. The Centre was set up as a limited liability company with a Board of Directors (comprising mostly of the heads of the ceramics industry firms), was housed as a small unit within the government Industrial Technology Institute (ITI) premises, and had links to the universities of Moratuwa and Peradeniya in Sri Lanka and Alfred University in the US.

Although initially hailed as a model for industry-research collaboration that other sectors could emulate, there does not appear to have been a significant contribution of the Centre to enhancing performance in the ceramic industry. However, this cannot be conclusively judged as no evaluation has been conducted. The critical constraint to its operations is the lack of a full-time manager. The Centre has found it difficult to attract and retain a dynamic manager due to the limited scope of the Centre's work. Moreover, the staff of the Centre (mostly ITI technicians on secondment) had not sought to actively engage with the industries, seek projects, offer testing services, etc., and rather waited for them to approach the Centre.

Although the performance has been lackluster so far, the ceramics companies had been satisfied with the few testing projects that had been undertaken by the Centre in the past. It appears that the ceramics industrialists recognize the importance of the establishment, and discussions are underway to restructure and revive it again. As part of the restructuring process, appointment of a second tier of directors is being mooted, which will comprise of the most senior technical officers of each firm. This aims to ensure that each firm takes a greater interest in the Centre, and engage it in research and testing.

Source: Interview with former President of Ceramics Council and current Board Director of the CENTEC, and Lanka Business Online (LBO), 'Lab Edge - Sri Lanka opens ceramics R&D lab *to enhance competitiveness', 5th April 2007 http://www.lankabusinessonline.com/fullstory.php?nid=1326052179 [accessed on June 13th 2012].*

[20] *Ministry of Technology and Research, Science, Technology and Innovation Strategy (2011-2015).*

first plant to produce titanium oxide from mineral sand. The new venture would allow value to be added to mineral sands, which have so far been exported from the country in raw bulk form. The setting up of the plant will allow production of titanium oxide from ilmanite, obtained from mineral sands extracted from Sri Lanka's Pulmoddai region. SLINTEC is also spurring international collaborations. Recently, a partnership was formed between SLINTEC and Nagarjuna Fertilizers and Chemicals Ltd. of India to develop nanotechnology-based plant nutrition solutions with an estimated investment of Rs. 800 million. SLINTEC is set to carry out research while Nagarjuna will develop the product.

Similar industry-research partnerships in areas aside from nanotechnology need to be cultivated, drawing encouragement from SLINTEC's successes. There are some limited examples of this, for example in the ceramics industry and in the mobile communications industry (see Boxes 7.4 and 7.5). Sri Lanka can learn from other country experiences as well. For example, Taiwan Province of China has used R&D consortia to foster cooperation between laboratories in the government-funded Industrial Technology Research Institute and local private enterprises. This joint effort has resulted in technology transfer and innovative processes and products.

Box 7.5
Telco Giant Dialog Axiata Partners with Moratuwa University for Research Lab

The first ever research lab for Telecommunication Technologies Research was opened at the Moratuwa University, which is acclaimed to be one of the best in Sri Lanka for engineering and telecommunication programmes. The first of its kind in Sri Lanka, the laboratory, which specializes in Applied Mobile Telecommunication Technologies Research, was set up as a part of Dialog's social investment towards uplifting and facilitating R&D and higher learning in Sri Lanka.

Applied research projects and product development initiatives that are beneficial to the industry, and are academically challenging are undertaken by the laboratory, whilst providing for technology transfer with similar research bodies. New ideas in wireless communication, which encompass the spheres of designing, prototyping, testing, and training are explored, with the objective of developing new products and services that will serve the purpose of taking Sri Lanka to the forefront of mobile technologies, thereby ensuring Sri Lanka's place in the challenging and evolving world of mobile technology.

Two creations of the laboratory – a remotely activated GSM alarm device and a learning management system – are being used in two Dialog-supported national initiatives, namely the Disaster and Emergency Warning Network (DEWN) and the Digital Bridge, respectively.

"The Dialog-University of Moratuwa Mobile Communications Research laboratory is a realization of the University's dream to actively interact with the private sector for mutual benefit, through the development of relevant and innovative technologies" - Prof. Dileeka Dias, Director, Dialog-University of Moratuwa Lab

Source: Dialog Axiata website, available at http://www.dialog.lk/about/responsibility/outreach-cr/research-lab/.

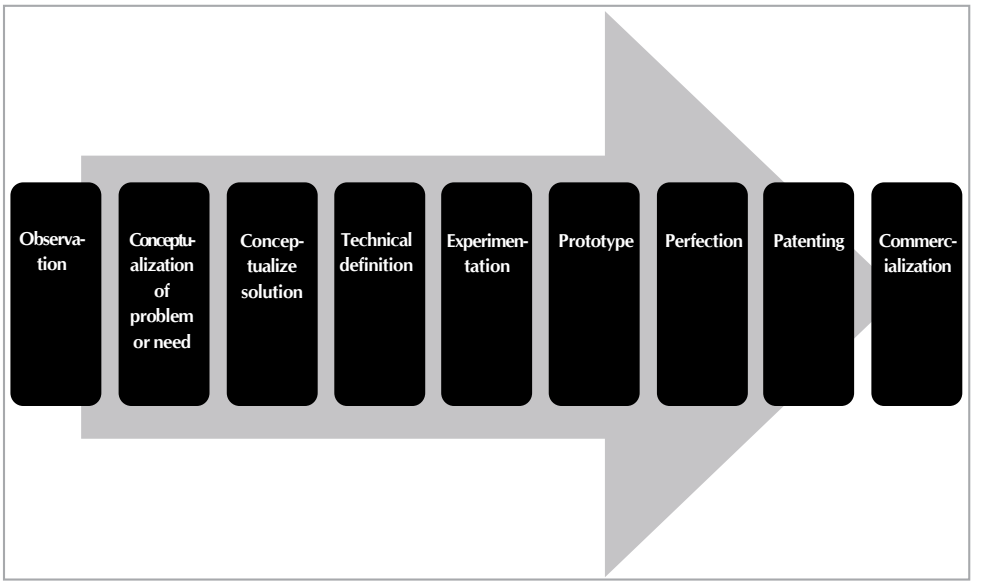
Commercialization

Commercialization is the final stage of a process of innovation where a product has come from a R&D stage to a market-ready product (Figure 7.7). This is the most challenging part of technology-based innovation. Support for commercialization (in terms of product development, patent applications, and finance for business spin-offs), which is essentially the pinnacle of an innovative process, is lacking in Sri Lanka.

According to the Sri Lanka Inventors Commission (SLIC), several inventors in the country have been able to commercialize their inventions, noting that at present there are 14 commercialized inventors in the category of Rs. 1 million capital or less, six with Rs. 1-5 million, two between Rs. 5-10 million, and five with a capital of over Rs. 10 million.[21] In Sri Lanka, independent inventors have limited options to build and refine prototypes in preparing for commercialization. University facilities are already resource-constrained and may not be able to offer free or concessionary-rate services to build prototypes, while private firms are unlikely to provide these services unless the technology can be ex-ante acquired from the inventor and owned.

A recent example of efforts to support commercialization through 'techno-entrepreneurship' by the government is the unique 'Technology Marketplace' hosted by the Ministry of Technology and Research held in late 2011. The initiative, hailed as a success for a first-time event, brought together all of the government research institutions together with interested private sector parties, to see if productive partnerships to commercialize research can be forged.[22]

Figure 7.7
The Process of Innovation



Source: Sri Lanka Inventors Commission Strategic Plan (2012-2014).

[21] http://www.sundaytimes.lk/120415/BusinessTimes/bt018.html.

[22] 'Technology Marketplace Hailed as Great Success', *Daily FT*, available at http://www.ft.lk/2011/10/26/ %E2%80%98technology-marketplace%E2%80%99-hailed-as-a-great-success/.

Financing

Financing innovations is a key challenge in Sri Lanka. The challenge is particularly true for SMEs in the country. In an environment where general access to finance for SMEs are a severe constraint,[23] finding finance for innovations maybe tricky, as banks are already risk-averse when it comes to SME lending. While some efforts are being made to address this, for example by the SLIC (in allocating funds to support patent applications and inventions labs for prototype building) as well as the NSF (particularly in funding start-ups), this needs scaling up and made accessible to more individuals and institutions.

Venture Capital (VC) is an important financing source for tech start-ups globally, and was a critical success factor in creating the booming IT industry in 'Silicon Valley,' California. Previous attempts at VC showed mixed results, with some trailblazing firms emerging as a result of it, but also a sudden decline in VC-led activity (see Box 7.7). Currently, VC activity in Sri Lanka is very tempered and the government would need to revisit the past experience and see how best to stimulate the VC industry in Sri Lanka once more, with a particular focus on aiding innovation.

Box 7.6
National Science Foundation Launches Grant Scheme Supporting Tech Start-ups

The National Science Foundation (NSF) has recently called for applications for a new technology grant scheme called "Support for Start-up Businesses Based on Novel Technologies." It states as its rationale, "having considered the fact that many research and experimental development projects are confined to laboratories without progressing into commercial applications and also with a view to develop an entrepreneurial culture among researchers/scientists/engineers in the research institutes and universities..." The scheme aims to provide an opportunity for start-up companies or spin-offs using university/institute-based new technologies. This grant programme rightly identifies that entrepreneurs often find it difficult to obtain necessary seed funding in financial markets given the financial risks involved in establishing technology-based start-up companies or corporate spin-offs stemming from novel technology research and development.

The objectives stated by the NSF for this grant scheme are:

- Convert university and research institute research outputs into marketable products/ services
- Encourage scientists, researchers, and engineers to become successful entrepreneurs
- Encourage establishment of new technology-based firms by state and non-state organizations and individuals
- Promote technology transfer and commercialization of new technologies

Source: www.nsf.lk

[23] 'Wijesinha, A. (2010), "Post-Conflict Sri Lanka's Enterprises Struggle to Grow", 'In Asia', The Asia Foundation Blog available at http://asiafoundation.org/in-asia/2010/10/13/post-conflict-sri-lankas-enterprises-struggle-to-grow/.

Box 7.7
Previous Efforts at Venture Capital in Sri Lanka and the Banker's Trap

The VC industry in Sri Lanka emerged in the early 1990s, resulting from a government decision to provide fiscal incentives for VC funds (tax deductability for investment in approved VC funds and a 10-year tax holiday for VC profits). Prior to 1990, no VC firms existed in Sri Lanka. However, by 1992 there were seven.

The two development banks at that time, National Development Bank (NDB) and Development Finance Corporation of Celyon (DFCC), one state bank - People's Bank, one private bank – Commercial Bank, two investment banks – DCIC and Asia Capital, and one finance company jointly with another private bank – Central Finance/Hatton National Bank (HNB) floated VC subsidiaries, launching seven VC funds. By the end of 1992, all seven funds were qualified and in the years 1993-1996 they made 76 investments, an average of just over three investments per year, per fund. The average in 1997-1999 dropped dramatically to less than one investment per year per fund. This drop reflects that the funds had invested much of their capital by 1997. The per-investment average (for the decade) was about Rs. 10 million.

The total funds base of all seven VC companies was around Rs. 1.5 billion. All seven VC companies collectively invested Rs. 1 billion in 101 projects during the 9 years from 1991 to 1999. A study funded by USAID revealed that the performance of only 1 out of the 101 investments truly qualified as a 'successful VC investment' in terms of a return equal to a significant multiple of the value of the original investment.

The successful VC investment was Millennium Information Technologies (MIT). The VC fund PVIC was the only company to invest in MIT when it first bid for the computerization contract at the Colombo Stock Exchange and required expansion. PVIC invested Rs. 7.5 million in 1996. In 1999, PVIC sold its stake to a foreign fund for Rs. 43 million, a 573 per cent return on investment. Subsequently, MIT sold out to the London Stock Exchange for US$ 30 million.

The defining feature of all these VC companies, as clear from the list of VCs given above, was that they were all subsidiaries of banks. The Boards of Directors of these companies were filled largely by veteran bankers. Moreover, even much of the senior management positions of the VC funds were taken up by bankers seconded from the parent companies. An important feature of banking is 'downside protection.'- Bankers are, by training, keen to minimize the overall risk of an investment portfolio by diversifying across the different variables such as the sector, stage of growth, and size of investment. This was in line with the standard investment theory of hedging against the downside risks of an investment portfolio by investing in assets whose movements are negatively correlated with each other.

Essentially, the funds were managed by bankers with a 'banker's mindset' rather than by venture capitalists with a 'venture capital/risk capital mindset.' In deciding on the investments, they chose 'moderate risk, moderate return' projects, with a heavy focus on 'downside protection' as highlighted earlier. As the VC companies rarely had industry experts, enterprise experts, and those with strategic business development expertise, these funds did not really pick 'winning firms,' i.e., firms with high intellectual capital and extremely strong upside potential if the right guidance and hand-holding was provided. Furthermore, as the VC companies employed predominantly bankers, the firms that received the investments received little or no management, operational, and strategic input from the VC Company. By the early 2000s, many of the companies invested in by the VC funds had either returned only modest returns, or had underperformed completely; and consequently, many of these VC funds themselves failed.

Source: Wijesinha, A. (2011), 'Introducing Venture Capital for Traditional and Small Enterprises in Sri Lanka', Briefing Paper, Policy Strategy Committee, Ministry of Traditional Industries and Small Enterprise Development, April 2011.

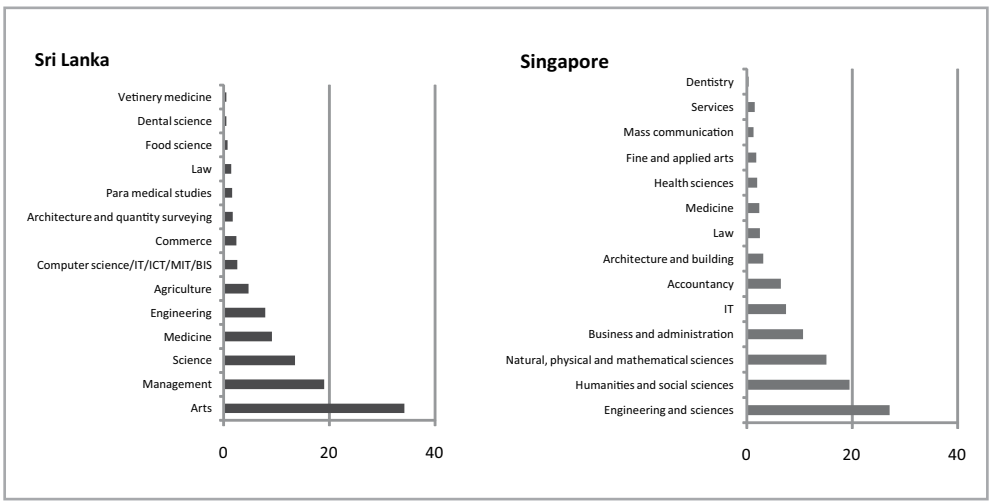
7.7.3 Talent Pool for Innovation: Investing in S&T Education

Limited Supply of Relevant Talent Pool

Building a qualified pool of individuals geared towards S&T and R&D will be critical to Sri Lanka's innovation ambitions. Education -- especially science education at all levels -- is important not only for increasing general science and technology literacy, but also to build up a critical mass of scientists, researchers and engineers. While these are indicated as priorities for Sri Lanka under the 'knowledge-hub' initiative, several supply-side bottlenecks need to be overcome. Although in the higher education section of 'Sri Lanka: Emerging Wonder of Asia' document, it states that, "...higher education policy will focus on "fostering a culture of research and innovation...," it is clear that this will be a major challenge by virtue of the fact that very few students are engaged in science and engineering courses at Sri Lankan universities.[24] Compared to a distinct knowledge-led economy like Singapore, where the majority enrolment is in engineering sciences with nearly 30 per cent, in Sri Lanka the majority enrolment is in Arts, with over 30 percent (Figure 7.8).

Yet, this cannot be only attributed to A/L students preferring arts and humanities streams over science and engineering. It is, more critically, a reflection of the limited number of schools that offer science stream classes at A/Ls, thus constraining those interested from undertaking it. Only 10 per cent of all secondary schools in the country have a science stream at the A/L (Grades 12-13). This naturally restricts the number of students who are able to gain admission to science and engineering programmes in university. Moreover, there are significant spatial disparities as well. Even schools that do offer science education are not rationally located, with the majority located in the Western Province. The School Census (2008) of the Department of Census and Statistics reveals that there was one school with A/L science

Figure 7.8
Tertiary Education Enrolment by Subject Area - Sri Lanka vs Singapore



Source: Arunatilake, N., (2011), "Making Everyone Work for Growth: Creating a Winning Workforce", presentation at IPS Annual National Conference, October 2011.

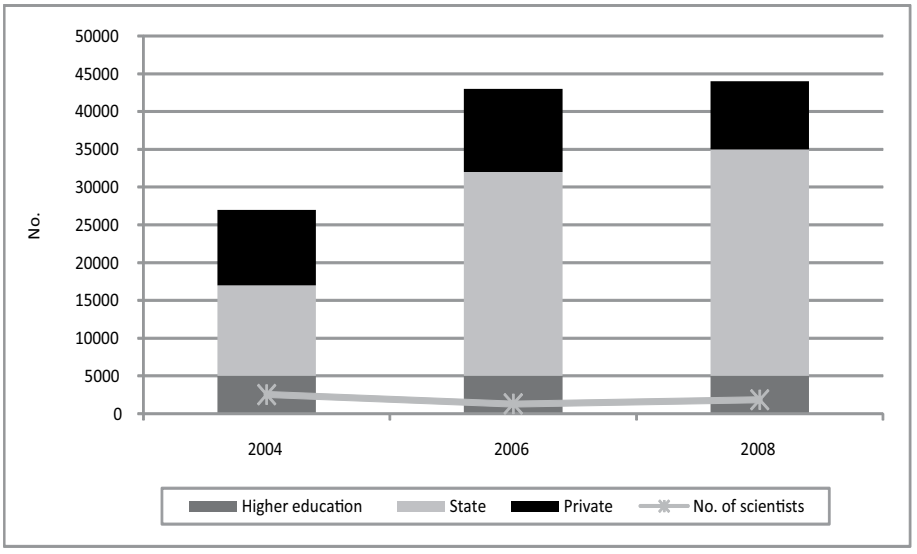
[24] This is, of course, aside from the broader challenge of expanding tertiary education in Sri Lanka, where at present, of more than 100,000 deserving students with the necessary A/L qualification, only around 15 per cent gain entrance into university (IPS, *Sri Lanka: State of the Economy 2011*).

stream for every 400 km^2 in Mullaitivu and Vavuniya, and for every 200 km^2 in Mannar; while there was one for every 10 km^2 in Colombo, 25 km^2 in Gampaha and 45 km^2 in Kandy. It also revealed that 80 per cent of schools in Killinochchi did not have science labs, while only 11 per cent of schools in Colombo and 10 per cent of schools in Gampaha suffered the same problem. These issues become especially pertinent in Sri Lanka's post-conflict context where inclusive growth and equity in economic opportunities need to be central concerns.

At the qualified-professional end of the spectrum too, Sri Lanka fairs poorly but has been showing improvement. Sri Lanka records only 237 researchers per million people, well below the developing country average of 374.[25] However, the total number of S&T personnel has increased from around 27,000 in 2004 to around 44,000 in 2008, recording a 60 per cent increase (see Figure 7.9). This stems mainly from the expansion in the state sector, recording over two-fold increase, with the higher education and private sectors expanding only marginally. However, the number of scientists has marked a declining trend over time, where the number between 2004 and 2008 recorded a significant fall of around 700. Scientists in the state and private sectors have improved in numbers, while those in the higher education sector have dropped considerably. Comparison of 2006 and 2008 status, nevertheless, indicates that all three sectors are improving in terms of the strength of scientists.

Sri Lanka produced just 2.5 PhDs per year on average during 1991-2000 in 7 universities (Colombo - 5 per year and Peradeniya - 6 per year).[26] Meanwhile, qualification levels of

Figure 7.9
Science and Technology Personnel by Sector (1966 - 2008)



Note: S&T personnel include all scientists, technicians and supporting staff involved in S&T research, service and management activities.

Source: National Science Foundation, *R&D Survey 2008*.

[25] World Bank (2008), 'Building Sri Lanka's Knowledge Economy'.

[26] Gamage, S. (2008), "Sri Lanka's Innovation System According to the 2008 Building the Knowledge Economy Document of the World Bank: A Critique', presentation at LirneAsia, March 25, 2008.

university faculties remain poor, with 23 per cent of humanities and social science teachers having only a Bachelors degree and 33 per cent having a Masters degree from the same university.

Addressing Not Only Supply but also Demand

The improvement of higher education will not be fully effective at stimulating innovation unless it is also accompanied by an expansion of opportunities for graduates to apply their skills and talents. With a significant amount of R&D activity occurring in the private sector, business enterprise serves as a primary source of demand for S&T specialists. By providing employment opportunities and career paths for scientists and technologists, enterprises encourage students to enroll in scientific and technological fields. As more students graduate with relevant skills and motivation, this growing pool of human capital will, in turn, attract more enterprises to the region, thus creating a virtuous, self-reinforcing circle of technological capacity development and R&D activity. Governments could review whether firms, particularly SMEs, face negative or positive incentives when hiring university graduates. Possible positive incentives could include tax breaks or financial aid, to support internships or offset the initial cost of hiring and training new employees. Enterprises could also be encouraged to employ students as interns or part-time researchers, laying the foundation for later employment.

7.7.4 Incentives for Innovation

Incentives for innovation in Sri Lanka are mainly in the form of tax concessions and tax breaks for R&D, and this too particularly through the most recent 2012 Budget proposals announced in November 2011. The tax incentives announced were:

- Reduction of income tax on research income from 24 per cent to 16 per cent.
- Reduction in personal income tax of all those engaged in research and technology from 24 per cent to 16 per cent.
- Reduction in income tax on all institutions engaged in research and technology to 20 per cent and such institutions are exempt from VAT.
- Triple deduction in relation to R&D expenditure undertaken by enterprises through government institutions, to promote private institutions to use government research facilities.
- Government institutions to extend research facilities to SMEs at a nominal fee.
- Allocation of 50 per cent of research related income earned by government institutions carrying out research for the private sector, to be shared among such researchers as a promotional allowance.
- Allocating Rs. 300 million to the National Research Council to encourage special research that would facilitate economic development.

These measures have been commended by private sector groups.[27] However, interviews with leading industrialists revealed that several key challenges may constrain the aforementioned incentives: (i) the small number of suitable government research institutions capable of catering to industry needs (the ITI was the only one mentioned by those interviewed); and (ii) limited capacity in, and low-industry orientation of, government research facilities. However, this is a vicious cycle and needs to be broken. Government research institutions cannot develop greater industry-orientation without kick-starting this process. Meanwhile, Sri Lanka's private sector needs to be given confidence in the abili-

[27] "National Chamber Commends the 2012 Budget Proposals", *The Island*, November 22, 2011 http://www.island.lk /index.php?page_cat = article-details& page = article-details&code_title = 39577 [accessed on 1 May 2012].

ties of government research institutions, and for this their financial and human resource capacities need to be expanded.

Budget 2011 too had announced the granting of a research allowance to university staff and researchers to incentivize them to conduct more research. However, the scheme has only been in place for less than a year, and it is unclear as to the impact this incentive has had in terms of spurring more research among university academics. Moreover, the budget proposal did not specify which areas of research this would be applicable to, and it is likely that it is not a focused measure meant just for S&T research. Additionally, the element of innovation has not come in, where commercializing research is incentivized through this allowance.

7.8 Importance of International Openness and International Cooperation for Innovation

Much of the literature on innovation points to the importance of 'international openness' as an important element in spurring innovation. The literature emphasizes that domes-

Box 7.8
Staying Linked with Innovation Leaders - US, Germany, China and India

As Sri Lanka's innovation capacity is at a nascent stage, it will be important to develop linkages with the technology and innovation leaders of the global economy. In the midst of the antagonism stemming from the issues surrounding the end to the armed conflict, Sri Lanka must find a strategic balance with the West, particularly with innovation leaders like the US. Despite its current economic troubles, the strength of the US economy lies in its capacity to invent and innovate. These inventions are converted into commercial or military products at a rate much faster than in other countries. Many social factors and flexibility in economic policies contribute to this innovative dynamism. America's gross domestic expenditure on R&D is the second highest in the world (next to Japan) and has consistently been higher than the OECD and EU average. It accounts for a significant 43 per cent of all pharmaceutical patents, half of all medical patents and almost 20 per cent of all environmental patents. In addition, it publishes nearly 280,000 scientific articles each year, the highest in the world.

Meanwhile, Europe has its own leaders, especially Germany. Products with the insignia 'Made in Germany' still command an unrivaled global position, renowned for their high quality and cutting-edge technology. In 2008, Germany spent around 2.6 per cent of its GDP on R&D, well above the EU average of 1.9 per cent. In 2009, firms based in Germany registered the third highest number of patents in the world. In an analysis of the world's leading innovation hubs, five German cities featured in the top 15 – Frankfurt, Hamburg, Berlin, Stuttgart, and Munich. The country boasts over 750 publicly-funded research institutions, the highest in Europe. Yet, it is the German private sector that leads the way in R&D. Of the 62 billion Euros spent on R&D in 2009, more than two-thirds were by the private sector. Germany's leadership in innovation and its sustained focus on developing a highly skilled workforce is what will help it adapt its economy well to the changing tides.

Closer to home, the Asian innovation leaders are China and India, but China is the clear frontrunner. While the economic relationships between Sri Lanka and China appear strong at the moment, much of the partnerships are related to infrastructure (ports, airports, railways, and roads). Sri Lanka can capitalize on the friendly economic ties on another, possibly equally important front, technology and knowledge transfer for innovation. China has 708 researchers per million people compared to 119 in India. By 2009, China had over 16,000 PhDs in science and engineering, while India had around 6,400. In 2007, the Chinese filed 245,000 patents compared to 35,000 in India. China is set to overtake Japan as the second largest spender on R&D after the US in the next two years.

Source: Wijesinha, A., 'Sri Lanka in a Changing Global Economic Landscape', Public Lecture at the American Centre, 22 September 2011, Colombo.

tic innovation cannot be achieved without greater openness to international trade and investment and greater access to international markets.[28] Technology transfer through heightened trade and investment linkages is a key way in which the level of domestic innovation gets upgraded. Sri Lanka has not moved fast enough on international trade and investment treaties. It is yet to agree on a CEPA with India, and no ambitious treaties with other nations are in the pipeline. Sri Lanka needs to consider moving more aggressively on technology partnership agreements at least like that between India and the US, for example, in its thrust to become a knowledge hub (see Box see 7.9). For this, looking both East as well as West will be necessary (Box 7.8).

7.9 Reversing 'Brain Drain' and Leveraging the Diaspora to Strengthen Innovative Capacity

'Brain drain' was first used to describe the outflow of scientists and technologists to the US and Canada in the 1950s and early 1960s. Now it is used more generally to imply the outflow of technologically, professionally and academically qualified persons towards developed countries and to other fast-developing countries. As such, 'brain drains' between home and host nations are perhaps the most widely recognized demography of scientific and technical human capital diffusion trends.

The problem of scarcity of human capital for innovation is exacerbated in many developing countries by serious problems of 'brain drain.' By some estimates, up to one-third of R&D professionals from the developing world reside and work in OECD countries.[29] With decades of conflict, security and political uncertainty, and the resultant laggard economic growth, Sri Lanka has faced significant 'brain drain' over the past couple of decades. Consequently, academic and research institutions in the country have not sufficiently expanded to absorb graduates in S&T, and sufficient employment opportunities in commercial sectors have been slow to emerge. The conditions of work are less attractive in Sri Lanka than in developed countries, where professional opportunities are more enticing, funding is more forthcoming, and there is a consequent lack of a critical mass of researchers required to create active research communities.

Box 7.9
India Partners with US for R&D Center

The agreement to initiate a Joint Clean Energy R&D Center in India was one major outcomes of US President Barack Obama's visit to India in 2010. India and the US pledged to make an effort to promote clean energies through the initiation of this Joint Clean Energy R&D Center. The Joint R&D Center will focus mainly on solar energy, energy efficiency, bio-fuels, clean coal technology and an integrated gasification combined cycle project that turns coal into synthesis gas. Apart from its contribution to sustainable economic development, the joint venture is also projected to contribute to the Indian economy by creating a number of new jobs in India.

Source: http://www.ens-newswire.com/ens/nov2010/2010-11-08-02.html.

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[28] UNCTAD (2011), "Key Aspects of Entrepreneurship and Innovation Policy Framework for Enhancing Local Productive Capacities", UNCTAD.

[29] *Ibid*.

[30] Anas, M.U.M. and Wickremasinghe, S., (2010), "Brain Drain of Scientific Community from Developing Countries: The Case of Sri Lanka", *Science & Public Policy Journal*, 38(5):381-388.

A study using a database of 220 expatriate scientists and technologists, available in the expatriate scientists' database of the Science and Technology Management Information System of the NSF, reveal that the most commonly cited reason by expatriate scientists for leaving Sri Lanka was to gain further qualifications and/or develop skills (71.3 per cent), followed by better career advancement opportunities (59.4 per cent agreed).[30] The study further reveals that expatriate scientists were also concerned about issues such as lack of intellectual leadership, suitable role models, recognition and incentive schemes, and excessive bureaucracy. However, on the question of returning to Sri Lanka, the study was equally revealing. An overwhelming majority (96 per cent) of the scientific community surveyed noted that, if their needs are adequately met they would be willing to return to Sri Lanka. Of them, nearly a half would prefer to work permanently in Sri Lanka. Better working environment or working conditions, as well as adequate salaries and benefits were the main needs they would consider for returning. The study quotes a qualitative interview with a senior manager of a well-established private company who observes "that many private sector industries in Sri Lanka have overlooked the issue of creating job opportunities for science graduates and there is a very weak university-industry institute partnership. Since we offer better salaries to them than the government sector, making use of them towards a knowledge-based economy should help reduce the brain drain of the country."

While providing a dynamic environment for graduates to engage in innovative activities and thereby stem the brain drain, it is also important to encourage expatriate scientists to return to their native country. Returning expatriates bring with them much-needed tacit knowledge about new scientific methods, equipment and promising areas of enquiry, as well as collaborative networks that they have built which can help in national innovation efforts in their country of origin.

Several countries have useful schemes aimed at this. For example, India's Council for Scientific and Industrial Research provides temporary employment to highly qualified Indian scientists and technologists returning from aboard as a means of eliminating the uncertainty and economic problems faced by potential returnees from abroad.[31] Establishment of 'science parks' could also be useful to provide a dynamic environment for expatriate scientists to return for regular periods and conduct collaborative research with local partners, and teach or undertake specific projects at 'home.' Such science parks are currently established in India, China, Korea, and Thailand, among other countries. The 'Sri Lanka Emerging Wonder of Asia' document states that such projects will be initiated in Sri Lanka too, noting that "two science parks will be established in the Southern and North-Western Provinces with a view to facilitating high-tech industries to operate in a dynamic environment that enables them to nurture ideas, innovate and develop. These science parks will contain fully equipped laboratories and office spaces, innovation centres to bridge designers and industries and convenient amenities for both local and overseas companies alike." (p.122)

7.10 Way Forward for Sri Lanka

With technological transformations continuing at a rapid pace, and the emergence of a globalized market place, all countries are under pressure to become more innovative. For Sri Lanka too, adopting existing technolo-

[31] Krishna, V.V. and B. Khadria (1997), 'Phasing Scientific Migration in the Context of Brain Gain and Brain Drain in India', *Science, Technology & Society*, Vol. 2, No. 2.

gies and best practices, while gradually developing new ones, is the quickest way for its products to move up the value chain and for its economy as a whole to move up the development ladder. If Sri Lanka is truly aspiring to be a knowledge-hub, it needs to take the creation of an innovation culture and an innovation system more seriously. Fostering a forward-looking innovation system that supports knowledge-interaction among various parties and commercialization is critical. In Sri Lanka, the general underdevelopment of the individual components of the innovation system, as well as the nexus between them, is a symptom of the low priority given to S&T and R&D investment over the past several years. This may be largely attributed to the distraction of the country's long conflict. In post-conflict Sri Lanka, reversing this will be a key determinant of the country's competitiveness in the coming decades.

This Chapter stresses weaknesses on several fronts, which highlight the need for holistic policy action. Greater investment in R&D is a must, but prioritizing the fields to which the funding needs to be directed should be carefully planned. The R&D undertaken, without limiting to publications, should be taken forward to research outputs with a commercial value so that there will be a contribution to the growth of national production. Instead of the present context where the bulk of R&D expenditure is by the state, creation of an enabling environment for greater private sector involvement is essential to better commercialize S&T research. In moving from research to innovation, improving industry-research association is key in order to adapt research to the needs of the economy. Focus on generating means to finance innovation, scaling it up as well as making it accessible to more people/institutions. Expanding and deepening the talent pool is another area calling for urgent attention. Creation of more space in the science stream in the education sector is essential. in addition, attracting enterprises, both local and foreign, that will demand the knowledge and skills of scientists also needs to be addressed. Although Sri Lanka is in an advance position in terms of incentivizing innovation by way of tax concessions, to ensure full utilization of these, upgrading the research capacity of state institutes will have to be seriously looked into, particularly in areas such as industrial research, which have a direct contribution towards GDP growth.

A key point made in this Chapter is that innovation goes beyond just research. Innovations come from the entrepreneurs who make them happen and ultimately depend on a society's responsiveness and ability to transform research into something that adds value to people's lives, as well as, to the economy. Encouraging these entrepreneurs with appropriate policy support for 'techno-entrepreneurship' is important, for example, by setting a conducive business environment, providing better access to capital through VC, incentivizing commercialization of inventions, etc.

For a successful innovation policy to kick-in, it will need firm political backing to give credibility to the vision, and facilitate the adoption of key measures for removing bureaucratic hurdles. It is also important to have efficient mechanisms that facilitate cross-departmental cooperation, as by its very nature, innovation policy concerns parts of government that usually work independently. Therefore, this Chapter calls for a powerful National Innovation Council chaired by the President or Prime Minister which can drive the innovation policy agenda at a national, strategic level.Sri Lanka could consider incorporating the term 'innovation' in the official name of the relevant ministry mandated to overlook this area, as it would further demonstrate the government's commitment to the concept and its recognition of its importance.

Several countries already have this. For example, the Ministry of Economic Development and Innovation in Canada, the Ministry of Economy, Innovation and Development in Portugal, the Ministry of Science, Technology and Innovation in Malaysia, the Ministry of Science, Technology and Innovation in Denmark, the Ministry for Innovation and Technology in Austria, the Ministry of Economic Affairs, Agriculture and Innovation in the Netherlands, the Ministry of Science and Innovation in New Zealand, and the Ministry for Innovation, Science, Research and Technology in the state of North Rhine-Westphalia, Germany.

Meanwhile, rewarding and recognizing innovations is also important. In an environment where there are numerous award schemes in Sri Lanka, a Presidential National Innovation Awards scheme introduced to promote and recognize successful innovations, particularly those that have resulted from industry-research collaborations, will be of immense value. This should go beyond the currently operational Presidential Awards for Inventors, that takes a much narrower focus.

While much of the literature on the importance of innovation to economic development focuses almost exclusively on its impact on building more productive and competitive firms and products, Sri Lanka needs to look at the innovation imperative more holistically -- on how it matters to society as a whole. Innovations would be important not just for firm-level progress, but also social development. Innovations can lead to better ways of delivering public health care, safer and more efficient public transport, better disaster warning systems, etc.

In summary, Sri Lanka needs to take a holistic approach to innovation if it is to succeed in building a competitive economy capable of growing at a sustained, fast rate. Sri Lanka's competitor countries are moving forward at a rapid pace in this regard. Making innovation policy a key priority in the coming decades will determine how the country places itself in a rapidly changing global economic environment, delivering high growth and increased prosperity for its people.