APPENDICES

Appendix A. Case Studies in Competitiveness and Innovation

Finland's National Innovation System

Finland is considered to employ one of the most competitive economies and innovation systems in the world, according to Global Competitiveness Report. Research and development (R&D) in Finland's high-tech sector accounts for 3.45 percent of GDP, the second highest proportion in the world. The country's innovation system is built on cooperative networks of business and research and supported by efficient public policy and world-class infrastructure.

Pioneering a National System for Innovation

Finland was one of the first countries to adopt a national innovation policy and has been refining innovation initiatives and science and technology policies since the mid-1960s. The innovation strategy of the 1970s provided incentives for developing technical research, technical faculties, and research institutes and was preferred over science and university-based policy. In the 1990s, Finland adopted a comprehensive policy framework advocated by the OECD. Outlined in the National Innovation Strategy, the framework led to reforms in the science and technology sector, the development of regional innovation policies and regional technology centers (16 knowledge centers were established), national cluster programs coordinated by five ministries, and an environment conducive to the development of a venture capital sector. The strategy also led to a science policy strengthened by the Academy of Finland. The result is a tightly coordinated system of regulated high-tech clusters.

Thriving Telecom Industry Spurs Innovation

Forest-related products long dominated Finland's exports until the late 1990s, when the ICT sector began to flourish. Finland's highly competitive ICT and mobile telecom cluster has its roots in the 1920s, when several companies specialized in the manufacture of radio technology for the government.

Specializing in telecommunications, Finland's high-tech sector enjoys a very liberal economic environment and the driving presence of Nokia Corporation, which has been in the sector since 1967 and has developed through a sequence of mergers and acquisitions. Finland pioneered in several vital technologies, gaining first-mover advantages. For example, it was the first country to launch a digital network for mobile communications; the Nordic mobile telephony (NMT) standard, the first fully automatic analogue cellular phone system, was launched in 1982. And in 1991, the world's first Global System for Mobile communications (GSM), a digital standard for mobile networks and successor of the NMT, was launched in Finland.

Sector deregulation, which began in the mid-1980s and resulted in fierce competition, is viewed as a key driver of innovation in the Finnish telecom equipment industry. Finland's fully liberalized sector is in stark contrast to sectors in other OECD countries, where similar reforms did not start until the mid-1990s.

Nokia now accounts for 45 percent of industrial R&D in Finland, and more than 80 percent of R&D investment in the telecom sector. The ratio of the company's R&D expenditure to sales rose from about 2 percent in 1969 to 8.5 percent in 1999. Its gross spending on R&D combines internal and publicly raised financial resources. Despite the increasing absolute amounts, the share of the latter has declined considerably, going from 14 percent in 1981 to 0.3 percent at the end of the 1990s.

The first boom of the high-tech sector in the 1980s was followed by deep economic recession in the 1990s. The government prioritized the sector in the 1990s, although the recession resulted in significantly shrinking budgets in almost all sectors, and increased the budget for R&D. Increased R&D funding was provided both for public research and for incentives and grants for private firms to invest in R&D.

Cluster Concepts Shape Innovation Model

A model for systems in the Netherlands, Switzerland, Denmark, and Estonia, the Finnish system of innovation has several distinct elements: a holistic approach to sector development, establishment of intersectoral linkages in policymaking, high prioritization of the sector by the government, and tight networking among stakeholders. The core of the system, however, is the cluster concept.

After the publication of Michael Porter's *The Competitive Advantage of Nations* (1990), "clusterization" became central to Finnish technology policy. Government programs for raising innovation capacity in the 1990s included the Center of Excellence and the Cluster Program. An approach to cluster development based on technology, education, and competition was developed by the Research Institute of the Finnish Economy and outlined in the White Paper–a National Industrial Strategy—published by the Ministry of Trade and Industry. The country's resulting innovation cluster is shaped by academic, research and supporting institutions, the regulatory framework, and the private sector.

The central role of the private sector in the innovation cluster is reflected in its exceptionally high participation in R&D. Business R&D funding was estimated to have reached 2.44 percent of GDP in 2007. Several large corporations are not only major drivers of innovation but also major consumers of high-tech products. The right mix of policies, linkages, and institutions has resulted in an efficient innovation system in Finland.

Israel and Government-Driven Development

When asked why so many information security companies are founded and developed in Israel, the head of an Israeli high-tech company answered: "That is like me asking you why there are so many umbrella manufacturers in the UK".

Israel's unfavorable geopolitical situation and long-lasting conflicts have generated huge demand for domestic military production and a cutting-edge high-tech sector. Spillover from military R&D has created businesses in security and the high-tech industry. Israel's competitive R&D capacities are reflected in the number of its U.S. patents per capita, concentration of high-tech companies, level of venture capital as a percentage in GDP—the highest in the world—and density of high-tech start-ups with a success rate of 50 percent. The country's high-tech sector is one of its most attractive investment areas, with more than US$2 billon invested in 2008 (half provided by foreign funding) and another US$2.3 billion raised by Israeli firms in IPOs over the past 3 years.

Government Central in Innovation

The government has been an initiator of R&D sector development. Major steps toward an innovation-driven economy include the establishment of the Office of Chief Scientist (OCS) in the 1960s as a central authority on R&D policy and of the public nonprofit MATIMOP to help the OCS implement and oversee projects for getting Israeli industrial firms involved in bilateral and multilateral R&D projects. The government also passed the Law for the Encouragement of Industrial R&D (LEIRD) to foster science-intensive, export-oriented private industrial R&D, and implemented the Magnet Program in 1993 to strengthen collaboration between academia and businesses.

Quality Education Rooted In Military

Israel's world-class educational system ensures a high quality labor force for high-tech sectors. Israel has turned military service into a source of expertise and skills for many young professionals. The professional growth opportunities are then enhanced through funding of individual projects, such as Talpiot, a military program that has spawned many high-tech start-ups. Israel's scientific potential has also benefited from the mass immigration of skilled scientists from former Soviet countries at the beginning of the 1990s.

Sophisticated R&D Funding

Public Funding

The government directly and indirectly finances innovation. Direct financing is mainly through the LEIRD, a technological incubators program, and the Magnet Program. The latter operates in affiliation with OCS and the Ministry of Industry and Trade and provides grants to companies for generic R&D, technology transfer, basic and applied research, distribution, and implementation. Indirect financing is through tax concessions to organizations and companies that support innovation-oriented activities, such as MATIMOP; Inbal, a government fund; the Investment Promotion Center; and the Yozma fund, which attracts foreign capital for investment in the high-tech industry.

Venture Capital Funds

The government helped to form the venture capital industry by establishing several funds at the beginning of the 1990s. That was followed by an inflow of foreign funding in the form of another ten funds over the next several years. In 2005, the Silicon Valley Bank established a branch in Israel and the Israel Venture Association started programs to raise capital for Israeli start-ups worldwide. There are currently, 100 venture capital funds in Israel.

Private Funding

The government spearheaded R&D funding and the private sector followed. Private R&D funding comprised 3.64 percent of GDP in 2006, putting Israel ahead of all OECD countries on this indicator.

State Initiatives Liberalize and Internalize High-Tech Sector and Boost Export Sales

The Israeli government has long pursued a high-tech-intensive export strategy supported by the Law for the Encouragement of Capital Investment (LECI). Adopted in 1959, the law aims to increase exports and employment in least developed areas and to promote export-led businesses by providing grants and tax benefits on the basis of the percentage of foreign ownership and location. A 1995 revision of the Law for the Promotion of Industrial Research and Development (adopted in 1984) allows companies to request OCS permission and support for the transfer of know-how developed with OCS support abroad (before this revision, recipients of state support could not transfer technology and establish overseas production).

Security Industry

The Homeland Security sector (HLS) has long been the top priority for Israeli R&D. This is reflected in the government's expenditure structure, which used to provide 65 percent of R&D spending on defense in the 1980s.

The sector has formed a huge export base for the country. Sector development chronology reveals the government's role in creating an international science hub by providing incentives and generating demand for production, especially at the initial stage of market development.

The seeds of Israel's security industry were planted in the 1920s, when grenades and explosives were manufactured but in an unorganized fashion. The 1948 War of Independence led to the formation of powerful market players, such as Israel Military Industries (IAI) Ltd. and the Israel Aircraft Industries Ltd. Israel then began full-scale production of military weapons. The end of the 1950s was pivotal for development of the security systems industry: the Ministry of Defense established RAFAEL, an R&D branch that became the largest base for weapons development, and MAMRAM, a central computing facility now a key player in software innovation. In the 1960s, Israel began its missile program and established business relationships with multinationals (e.g., the French company Dessault), enhancing export opportunities for the security sector. The emergence of Elbit, a firm specializing in military computers and civil applications, generated demand for know-how, a demand met by local military research organizations.

The government decided to achieve self-reliance in military applications after a short war in 1967, which was fought with French weapons and resulted in a French embargo on military applications to Israel. This drove the IAI to begin manufacturing fighter planes and weapons. The industry also tried, but without success, to develop its own military jet. This attempt, however, laid the foundation for manufacturing of aviation components. The emergence of the aviation sector in Israel boosted the country's exports and cooperation with aerospace and military manufacturers, and created a platform for spin-offs in electronics, computers, software, and burgeoning Internet sectors.

Israel now offers security solutions in aviation, maritime, transportation, command and control systems, counter-terrorism, security systems for international events, IT protection, physical security, and others. The sector is export-oriented with about half of its 600 companies exporting to international markets. The sector employs 25,000 people with exceptionally good educations and expertise, usually grounded in military service. Top companies include large military and defense companies—Elbit, Tadiran, Israel Aerospace Industries, RAFAEL, Elisra and Israel Military Industry.

The size of the small local market persuaded the government to create a favorable environment for companies to export. Cooperation with U.S. companies is nurtured through initiatives such as the HLS Masterkey Project, launched by the Israeli Export and International Cooperation Institute (IEICI) in 2004, and the Homeland Security Pact, signed by the two countries in 2007.

Formed under unfavorable geopolitical conditions and hardened through many challenges, the Israeli high-tech industry has become a benchmark for government-stimulated development. The byproduct of several military initiatives is a huge army of specialists and entrepreneurs spawning spin-offs and fostering innovation. As public spending decreases, the Israeli high-tech sector is increasingly driven by the private sector.

Silicon Valley and Organic Cluster Development

Silicon Valley is one of the world's most renowned technology clusters, supported by strong institutions, developed capital markets, an independent judiciary, an excellent educational system, research institutions, and advanced infrastructure.

From Fruit Orchards to High-tech Hub

The presence of Stanford University and its high concentration of scientists in the Santa Clara Valley shaped the development of the Silicon Valley technology cluster. Founded in 1891, the university has long been more than an educational institution. After World War II, it established Stanford Industrial Park to address the demands of the high-tech industry. Hewlett-Packard was the first company to establish its premises in the area. At the end of the 1970s, Silicon Valley recorded a huge number of start ups, the majority of them generating US$100 million in revenue by the 1990s. The many ventures established in the 1980s contributed to cluster diversification and world giants such as Apple, Intel, and Sun Microsystems began to emerge. In the 1990s, Silicon Valley hosted approximately 39 of the largest 100 companies in the United States and in 1990 accounted for over one-third of the country's exports of electronics.

Success Requires More than Industrial Localization

Silicon Valley is considered one of the world's leading economic clusters based on classic innovation mechanisms, well-developed infrastructure, and incentives for research and commercialization. New ideas are sourced from universities, research institutions, and labs. The university system is heavily engaged in applied research and entrepreneurial activities. Thus, a significant share of an academic researcher's income comes from commercialization of innovation.

Several leading educational institutions are at the heart of Silicon Valley's performance. Technologists and engineers from Stanford and other well-known universities form many start-ups each year and institutions attract a great deal of foreign talent. Foreign national specialists, comprising over one-third of the local pool of engineers, initiated a unique form of immigrant entrepreneurship that generates knowledge spillovers and cross-regional spin-offs. And immigrant entrepreneurship is on the rise: foreign executives ran 13 percent of start-ups from 1980-1985 and about 27 percent in 1991-1996. By the end of 1990s, one in three start-ups had been founded by foreign national entrepreneurs.

Capital markets are very important to R&D commercialization in Silicon Valley. Venture capital firms first emerged in there in the 1950s. The venture capital market grew swiftly from 1970 to 1975 and increasingly focused on the high-tech industry, thanks to specialized technology companies establishing venture funds at the initial stage of industry formation. Angel or seed funding is also expanding and supports innovative projects at earlier stages.

Currently, key cluster members are also the major consumers of R&D products. Market testing is carried out internally among the high-tech giants operating within the cluster. The stable source of demand strongly enhances the attractiveness of the industry for venture capital funds.

Singapore—R&D Hub for Multinational Corporations

Singapore's knowledge-based economy was developed in response to the demand of multinational corporations (MNCs) for R&D and supported by strong government policies. Its powerful technocenters attract leading MNCs' R&D functions.

The Global Competitiveness Study ranks Singapore one of the most innovative economies in the world. Singapore's R&D intensity exceeds the average OECD indicator and its R&D expenditures comprised 2.5 percent of GDP in 2007 and had an absolute value of US$6 billion in 2008. The government's strong commitment to R&D is reflected in about a thirtyfold increase in Gross Domestic Expenditures on Research and Development (GERD) within the period of 1981-1999 alone. The private sector also recorded a fivefold increase in R&D funding in the 1990s. Currently, the share of business R&D funding comprises two-thirds of GERD, with a dominance of foreign companies.

MNCs Central to R&D

Singapore's knowledge economy developed in distinct phases. From 1965 to the mid-1970s, there was industrial growth with a high rate of technology transfer from MNCs; the mid-1970s to 1980s were marked by rising technological sophistication and the development of local supporting industries and technological infrastructure; the 1990s saw expansion of applied R&D mostly tied to MNCs and the formation of an inward innovation industry with a concentration in local start-ups.

The concentration of foreign capital in Singapore has changed over time as well. FDI concentrated in manufacturing in the 1960s swiftly moved to capital-intensive sectors in the mid-1970s. This shift toward higher-value-added segments accelerated after the regional competitors strengthened and the economic recession of 1985.

Strong Policies and Incentives

In the early 1980s the government decided to move the economy into higher-value added sectors and initiated policies to raise wages in anticipation of the shift from labor-intensive to technology-intensive sectors. R&D targets were maintained through tax incentives and favorable funding mechanisms, cost effective regulation and supply of highly-qualified specialists. The importance granted to innovation led to the development of a National Technology Plan in 1991, commissioned by the National Science and Technology Board.

Strong Industry Linkages

In 1980, the Singapore Science Park was established to develop a networking environment for R&D actors and to realize the benefits of proximity to research institutes. Other cluster developments have included establishment of powerful information infrastructure, telecom deregulation and privatization, establishment of economy-wide broadband network, enhancement and promotion of e-commerce, and e-government systems. In establishing the innovation cluster, policymakers capitalized on the inherent competitiveness of Singapore's location and supported the creation of R&D hubs. The government initiated a "technology corridor," allocating the Southwest of Singapore adjacent to the manufacturing premises of MNCs. One North, another R&D hub project, has been in the works since 2001 and is expected to be completed in 15-20 years. It includes a biocluster (Biopolis), ICT cluster (Fusionpolis), and a media cluster.

Highly Competitive Education Key to Innovation Cluster

Intense R&D linking high-tech industry and multinationals requires a huge pool of knowledge and know how. Singapore established a specialized educational system with tertiary education at its best. The government committed funding to attract foreign top-tier expertise, bringing such authoritative academic institutions as MIT, Wharton, John Hopkins, Shanghai Jiaotung University, INSEAD, and Chicago Graduate School of Business to the country.

State education initiatives were also critical to spurring collaboration between universities and businesses. Nearly all of Singapore's schools and training institutes conduct applied R&D and have linkages with the industrial sector, and the country has recruited top professionals from the world's leading organizations.

Thus, Singapore exemplifies how to respond to external demand for high-tech sectors and create an environment for knowledge spillovers and technology transfer throughout the economy.

Armenia's Synopsys—Encouraging Example

Synopsys Armenia CJSC is a subsidiary of Synopsys, Inc., one of Silicon Valley's leaders in electronic design automation with about 60 locations in 26 countries. Within a five-year period of operation in Armenia, Synopsys Armenia CJSC has become the biggest R&D center among these locations and one of the most successful MNCs in Armenia.

During Soviet times, Armenia was sometimes referred to as the R&D hub of the Soviet Union, especially for electronics. The collapse of the Soviet Union slammed the high-tech sector as old connections and contracts were lost, but the remaining talent pool began to attract foreign IT companies. Local companies also tapped into extensive Diaspora networks to establish cooperation abroad. Western companies that established subsidiaries or R&D centers in Armenia in the 1990s included HPL Inc., Boomerang Software, Credence Systems, Epygi Labs, LEDA Design, Virage Logic, and Synergy International Systems. By 2001, the government had prioritized the sector and established the IT Development Support Council.

Armenia was selected to host a Synopsys R&D center after a study of the country's potential, particularly its high quality software and electronic engineers working with reputable foreign-owned companies. Synopsis Armenia was established in 2004 as a result of an acquisition and merger between local operations of US-owned IT companies: Leda Design, specialized in chip design, and Monterrey Arset, specialized in the design of tools for analogue mixed signals. Later in 2005, Synopsys also acquired another US-owned IT company, HPLA, which developed software tools for semiconductor yield improvement. After merging with Synopsys Armenia, these companies have joined the global Synopsys structure as specialized departments. The personnel were also united from the acquired companies' pool of workers, which allowed Synopsys Armenia to draw on the experience of those employees. The rapidly extending activities of Synopsys Armenia soon required more employees. Beginning its operations with 130 workers, the company has stabilized employment at about 380.

Synopsys Armenia is known for its innovative solutions. It has created several EDA products strategic to Synopsys's position in microelectronics. The most important of these are Custom Designer, developed by the Analogue Mixed Signal Group (AMSG) and launched in 2008, and Yield Explorer, developed by the Silicon Engineering Group (SEG), launched in 2009.

Synopsys has nurtured the strong educational base that initially attracted it to Armenia. To enhance and promote local talent, the company has contributed to the training center of Leda Design. Local scientists and quality specialists mapped out the training center's curriculum, trainer requirements, materials, and technologies and the center has become the model for similar centers in China, Europe, and the Middle East. In 2006, Synopsys Armenia adapted the model for the Moscow Institute of Electronic Technologies (MIET). To strengthen cooperation between Leda and the State Engineering University of Armenia, Synopsys established a separate Faculty of Microelectronics with full curriculum and necessary equipment. The agreement with the Yerevan State University was signed in 2005. The company has also been cooperating with the Russian-Armenian Slavonic University since 2007. Synopsys also sponsors the Microelectronics Olympiad, which will become international in 2009, the Award of the RA President for the most outstanding IT students and other annual contests.

Synopsys is the success story of a large high-tech MNC operating in Armenia. It has helped expand the local IT cluster, improved local workforce quality, and exemplifies what other global IT operators can gain by making Armenia a destination for R&D operations.

Armenia's LT Pyrkal—From Collapse to Success

Specializing in crystals, optics and lasers, and exporting most of its commercial production as a fully commercialized venture, LT Pyrkal is an Armenian high-tech success story. Its predecessor organization—the Institute of Condensed-matter Physics—started in 1973 as a small laser laboratory affiliated with Yerevan State University and was led by renowned physicist Vilik Harutyunyan. The institute was a subcontractor to the Institute of Astrophysics in Moscow, which placed orders on behalf of the Defense Ministry. In its heyday, 1985-1987, it employed about 1,500 specialists and was one of the biggest research bases in the Soviet Union.

The collapse of the Soviet Union posed a major challenge; over the next ten years, the number of employees shrank drastically, going as low as 15 at one point. The institute came to a standstill and turned to filling small commercial orders unrelated to the high-tech sector. Revival began in 1997 through a joint venture with a foreign counterpart. The Government of Armenia then considered proposals for collaboration from the United States, Switzerland, and Greece, finally signing an equity partnership agreement with the Government of Greece in 1999.

Greek input was considerable in commercializing and internationalizing the company's products. When the LT Pyrkal joint venture was launched, Greece's Defense Ministry placed nine long-term orders for military R&D procurement. To fill the orders, the company recalled former employees and enhanced research capabilities. In addition to stabilizing demand, the Greeks led several vital business functions, such as marketing and finance. The firm's dependence on Greek demand was recognized as a point of vulnerability, and when cooperation with Greece became difficult and projects with the Defense Ministry were frozen as of 2002 the firm had to find new markets. Marketing was stymied at first by lack of experience and lack of action on the part of the Government. Forced to develop new capabilities, however, the firm managed to succeed in R&D product development and in commercialization. Demand grew through increased awareness and business contacts established at major exhibitions. The firm also attracted the interest of the domestic defense industry, which has been placing orders since 2004.

At present, Pyrkal employs 110 skilled professionals fulfilling largely commercial contracts (80 percent). The firm's clients include such high-tech companies as Light Age (USA), Zecotek Lab (Canada), SAAB (Sweden), Coherent (Germany), Quantel (France), and Lumenis (Israel). Despite the global economic downturn and a high rate of brain-drain, Pyrkal has promising plans for development.

Incentives	Infrastructure	Collaboration Between Business, Academia and Research	Government Agencies
ISRAEL			
INVESTMENT Approved or Beneficiary enterprise status based on the location to be eligible for getting grants of up to 24% of tangible fixed assets and or reduced tax rates, tax exempts and other benefits. **R&D** Conditional grants of up to 50% of R&D cost **Bi-national funds** 50% of industrial R&D full costs are subsidized; in case of universities 100% of additional costs and 20% of overhead **Global Enterprise R&D cooperation Framework** Financial assistance of 50% of Israeli company's R&D approved costs **TECHNOLOGICAL INCUBATORS** Grants of up to 85% of approved cost **Heznek Seed Fund** Grants of up to 50% of investment needs for approved projects for startup companies **Tnufa Program (pre-seed fund)** Grants of up to 85% of approved expenses for a maximum of $50,000 for each project to support individual entrepreneur **Magneton and Noffar Programs** Grants of up to 66% and 90% of approved costs to support applied academic research **MAGNET PROGRAM** Grants of up to 66% of approved budget to support the formation of consortia of individual firms and academic institutions.	**R&D FUNDING** First in the world in civilian R&D spending as a proportion of GDP at 4.6%, compared to OECD average of 2.26%. 138 R&D professionals per 10,000 employees – about three times higher than in the UK. **VENTURE CAPITAL** Yozma program – triggered (1992) the establishment of venture capital market. 100 active venture capital funds (2005), with major US/EU venture capital funds operating their branches in Israel (Silicon Valley Bank, Accel, Benchmark, Apex, Advent, Alta-Berkley, etc) and attributing to over 50% of the total dollars invested. **TECHNOLOGY INCUBATORS** 24 incubators (16 privately owned) with $30 million budget. Approximately 200 projects in various stages of R&D are hosted at any given time. By 2007, over 1,000 projects had matured and left the incubators. Of these, 57% have attracted private investments; 41% (since the beginning of the program in 1991) are still up and running. **NETWORKING** The Researchers Exchange program is aimed at creating a network of scientists for the benefit of science promotion. This included funding air travel tickets and living expenses for the 22 Israeli researchers who visit research institutions to promote international cooperation in common research areas.	**TRAINING SUPPORT PROGRAM** Plant Class- government supports training of workers in specific skills if the employer hires at least 50% of the class. Training and Placement Class- government fully covers the cost of running training for workers in specific disciplines if the employers hire at least 50% of class graduates within 6 months upon completion of the class. Internal Plant Training- government supports on-the-job training program in the premises of the employer by covering about $250-$350 per worker **FIRST-CLASS UNIVERSITIES** First-class universities established after founding of the state of Israel. 8 universities and 27 other academic institutes, out of which 6 are world-class academic and scientific research campuses. The THES World University Rankings (The Times Higher Education Supplement, 2006) ranked three Israeli universities among the 200 world leading universities. All universities have established Offices of Technology Transfer (OTT) in order to oversee and supervise patent registration and commercialization of new discoveries. The OTTs assist and support inventors and researchers in projecting their IP rights, commercializing IP, and forming optimal alliances among scientists, industry, and investors. Towards enabling the transfer of technologies to the business community, the OTTs play active roles in negotiating with strategic partners, licensees, and investors.	Office of Chief Scientist Ministry of Industry Trade and Labor Ministry of Communications Department: Information Technology Division

Incentives	Infrastructure	Collaboration Between Business, Academia and Research	Government Agencies
USA			
R&D INCENTIVES R&D tax credit within the Small Business Innovation Research Program (SBIR) SBIR program - awards up to $750,000 for projects in Phase I and up to $1.5 million for projects in Phase II The Alternative Simplified Credit ("ASC") provides companies with a credit of 12% of R&D expenditures, exceeding 50% of average R&D expenditures over the prior three years	**R&D FUNDING** GERD grew by 5.8% in 2007 and comprised 2.66 % of GDP with 368 bln USD in absolute terms Public funding is decreasing. Private sector accounts for 66.6% of R&D funding, government - 26.7%, universities - 2.7% **VC AND ANGEL INVESTORS** Venture capital industry is highly developed. The venture capital comprised 0.13% of GDP in 2006. About 40 venture funds in US raised about US$28,3 bln of venture capital in 2009.	**UNIVERSITIES** Highly specialized and high quality education. Significant portion of basic research is conducted by universities and colleges. The top 10 institutions in the country account for approximately 15 percent of total academic R&D. Strong university – private business collaboration	National Institute of Standards and Technology Department of Energy National Science Foundation Agency Central Intelligence Agency
SINGAPORE			
R&D INCENTIVES R&D and Intellectual Property Management Hub Scheme grants tax exemption for a period of 5 financial years in respect of foreign-sourced royalties or foreign-sourced interest remitted to Singapore, Enhanced Tax Deduction - an increase from 100% to 150% in tax deduction for R&D done in Singapore ***R&D Tax Allowance (RDA)*** Allowance of 50% of the first $300,000 of income chargeable to income tax may be used to offset taxable income in any subsequent year of assessment up to 2016 if the company spends more on R&D done in Singapore ***R&D Incentive for Start-Up Enterprises (RISE)*** Enables loss making start-ups spending annually at least $150,000 on R&D done in Singapore to convert up to $225,000 of tax losses to cash grants from the government. Also enables to carry forward those losses to offset against future years' taxable profits.	**FUNDING** Higher R&D intensity, compared to OECD average indicators. Total R&D expenditures made 2.5% of GDP, amounting 6 bln USD in 2008. Currently the share of business R&D funding is 2/3 in the GERD with the domination of foreign companies. **VENTURE CAPITAL** 150 venture capital companies with overall contribution in funds reaching 12 bln USD (25%-domestic, 40%-North America and Europe, 35%-from Asia) **TECHNOPARKS** Singapore Science Park – serves as an incubator for high-tech industries and R&D location One-North Science Habitat - includes a biocluster – Biopolis, ICT cluster – Fusionpolis, and a media cluster	Specialized educational system with world-class tertiary education is one of the most attractive factors for MNCs The university-business collaboration is enhanced through the "Technology Corridor", connecting industrial zones at the South-West of Singapore	National Science and Technology Board Economic Development Board Ministry of Communication & Information Technology (MCIT) Infocomm Development Authority (IDA) Media Development Authority (MDA) Intellectual Property Office Standards, Productivity and Innovation Board

Incentives	Infrastructure	Collaboration Between Business, Academia and Research	Government Agencies
FINLAND			
Special programs operate for stimulating radical innovation in SMEs. The extensive pool of incentives is embedded in the National Innovation Policy, first adopted in Finland in the 1990s.	**FUNDING** Heavy R&D investment both by public (3.45% of GDP) and private sectors (2.44% of GDP). Nokia accounts for 45% of all industrial R&D in Finland, and more than 80% of the R&D investment in telecommunications sector. 50% of public R&D expenditures are in the sphere of telecommunications. **NETWORKING** A network of international innovation centers are being established under FinNode program. The centers help Finnish scientist and companies establish contacts to clusters of excellence and encourage R&D projects.	Tekes technology programs drive cooperation between firms, universities and research institutes, potentially including foreign partners. The Science and Technology Policy Council established Strategic Centers of Excellence in Science, Technology and Innovation in the sectors of energy and environment; metal products TULI scheme by Tekes is addressed at the transfer of university research into business sphere. It has annual funding of 2,5 mln Euro. Nokia holds numerous contracts with Finnish universities and research institutes	Science and Technology Council chaired by the Prime Minister (the coordinating unit) The Academy of Finland National Technology Agency of Finland (Tekes) Finnish National Fund for Research and Development (Sitra) The Technical Research Centre of Finland (VTT)

Appendix C. Selected Macroeconomic Indicators, 1991-2009

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009 Jan-April
GDP growth, %	-11.7	-41.8	-8.8	5.4	6.9	5.9	3.3	7.3	3.3	5.9	9.6	13.2	14.0	10.5	13.9	13.2	13.7	6.8	-9.7
Wages, monthly average, USD	...	7.2	7.0	5.9	17.4	22.9	24.2	30.6	35.2	40.2	43.8	47.7	60.1	81.4	113.7	149.7	226.5	290.7	287.2
Inflation, CPI change (average)	174	729	1823	4962	176	18.7	14.0	8.7	0.6	-0.8	3.1	1.1	4.7	7.0	0.6	2.9	4.4	9.0	2.3
Inflation, CPI change (at the end of the period)	204	1240	10996	1762	32.2	5.5	21.8	-1.3	2	0.4	2.9	2	8.6	2	-0.2	5.2	6.6	5.2	3.1
Nominal exchange rate AMD/USD, average	...	193.1	1733.2	297.7	405.9	413.4	490.8	504.9	535.1	539.5	555.1	573.4	578.8	533.5	457.7	416.0	342.1	306.0	337.3
Real effective exchange rate, 1997=100	...	...	...	...	...	...	100	107	112.3	111.9	108	98.4	88.4	91.4	99.6	106.3	128.5	137.5	...
Export growth, USD, nominal, %	...	...	-24.4	37.9	25.8	7.2	-19.9	-5.1	5.1	29.7	13.8	47.8	35.7	5.4	34.7	1.1	17.0	-8.3	-47.8
National savings, % of GDP	24.4	-12	0.7	12.2	-4.6	-2.6	-5.3	-4.3	0.03	-0.6	3.3	8	13.4	15	19.1	23.1	25.8	...	...
Fiscal deficit, % of GDP *	1.6	-15.9	-11.7	-6.4	-6.0	-4.4	-2.6	-3.8	-5.2	-4.9	-4.3	-2.6	-1.3	-1.7	-1.9	-1.5	-1.5	-1.2	-3.4
Public Spending on social services, % of GDP *	...	...	...	5.7	7.4	5.4	5.1	6.0	6.6	6.2	6.5	5.5	6.0	6.1	6.5	6.7	7.0	10.2	19.3
Gross reserves (excluding gold), months of imports	...	...	0.6	0.9	1.6	2.1	2.3	3.5	4	4	3.9	4.6	4.4	4.6	4.6	5.9	6.1	3.8	5.6
Current account balance, excl. transfers, % of GDP **	...	...	-24.8	-33.3	-30	-29.7	-32	-30.6	-26.1	-24.4	-17.6	-13.5	-14.5	-12.6	-11.7	-12.7	-16.7	-20.9	-26.5***
Current account balance, overall, % of GDP **	...	...	-13.6	-16.5	-17	-18.2	-18.7	-21.3	-16.6	-14.6	-9.4	-6.2	-6.7	-0.5	-1.1	-1.8	-6.4	-11.4	-18.0***

* Since 2008 the budget classification has been changed, particularly social fund's spending have been involved in the state budget **Due to methodological changes in 2004 the data is not fully comparable *** Jan-March 2009

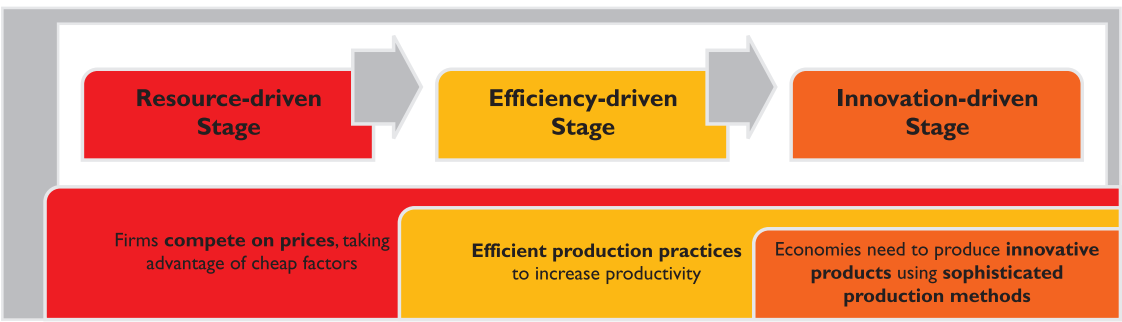
Source: NSS, CBA

Appendix D. GCR Methodology

Methodology

According to GCR methodology, three stages of economic development are defined (see Figure 4-1). In the first stage of development (resource-driven stage), the competition is based on the availability of abundant natural resources, cheap labor force, etc.; companies produce low value-added goods (basic commodities, unsophisticated goods); the share of extractive industry commodities in merchandise export comprises a very high percentage; the competition is based on low cost reflecting the low level of productivity of the particular nation. To stay competitive over the long-run, the countries in this stage of development need; to boost the efficiency of institutions (Pillar 1), modernize the physical and air infrastructures (Pillar 2); increase stability of the macroeconomic conditions (Pillar 3); and invest in health and primary education of the workforce (Pillar 4).

Annex Figure 4-1: The Three Stages of Development



Source: World Economic Forum, 2004, 2007, 2008, 2009

As the countries advance, they move into the second stage of development (efficiency-driven stage). In this stage, companies need to modernize the production processes, invest in the training of the workforce to upgrade the skills to produce high-quality goods and services. To maintain the competitiveness over the long-run, the companies need; to rely on the high quality of the higher education system that produces the graduates to be hired by the private sector (Pillar 5); a competitive environment urging enterprises to keep customers needs first (Pillar 6); a flexible labor-market regulation (Pillar 7); well-functioning and sophisticated financial markets to get access to funding to modernize production processes and upgrade the quality of products (Pillar 8); the ability to adopt new technologies (Pillar 9); and large foreign markets as an untapped potential to reach sophisticated consumers worldwide (Pillar 10).

In the third stage of development (innovation-driven stage), the private sector needs to sustain the high living standards and rising wages by boosting the productivity through heavily investing in R&D to market innovative high value-added, knowledge-intensive products and services (Pillar 12) along with upgrading the level of sophistication of business processes and strategies (Pillar 11).

Depending on the stage of development, different weights are assigned to the pillars for each stage. Higher weights are assigned to pillars that are crucial for the countries in each development stage (See Table 4-1).

Annex Table 4-1: Weights of the Three Main Groups of Pillars at Each Stage of Development

Stage	Basic Requirements	Efficiency Enhancers	Innovation and Sophistication Factors
Resource-driven Stage	60%	40%	20%
Efficiency-driven Stage	35%	50%	50%
Innovation-driven Stage	5%	10%	30%

Source, World Economic Forum, 2009

The classification of countries by stages of development is done based on two criteria: GDP per capita at market prices as a proxy of wages; and the share of exports of primary goods in total exports as a proxy of "*extent to which countries are factor driven*" (WEF, 2007). If the country exports of primary goods exceed 70% of the total exports, the given economy is considered as a largely resource-driven nation. The countries that fall in between two stages are considered to be in a "transition period", and weights of pillars differ as the nations advance.

Data gathering

The Global Competitiveness Index is calculated based on hard data and soft data. The majority of variables used in calculating the GCI index come from the Executive Opinion survey conducted by WEF's partner institutes among leading domestic and foreign companies operating within the borders of a given country/economy. WEF Global Competitiveness Network's partner institute in Armenia is the Economy and Values Research Center. The remaining variables comprise statistical data published by the World Bank, International Monetary Fund, International Telecommunication Union, Economist Intelligent Unit, National Statistical Sources, United States Patent and Trademark Office, World Trade Organization, International Labor Organization, UNESCO Institute for Statistics, etc.