National Innovation Systems in two Nordic countries: Sweden and Finland

Lessons learned for the development of effective innovation policy in Armenia

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ABSTRACT

Today Armenia strives to build a knowledge-based economy to improve its competitiveness. For this reason, the creation and development of innovation-supporting infrastructure becomes a critical challenge for the next few years. In this regard, the experience of developed countries in the design and implementation of innovation policies can be useful for the creation of National Innovation System (NIS) in Armenia. This thesis work investigates the NIS model in the Nordic countries, specifically in Sweden and Finland, and make conclusion on how the Nordic model of NIS could work in Armenia.

For this purpose, a comparative analysis of the NIS models in the Nordic countries, specifically in Sweden and Finland, with the NIS models in Israel and South Korea was conducted. To study the implementation of the Nordic model in transition economies, an example of one of Baltic countries - Estonia, was considered where currently this model of NIS is being implemented. Also, the current situation of NIS in Armenia was studied, and conclusions were made on what lessons can be learned for the development of effective innovation policy in Armenia.

An attempt was made to answer the following research questions supporting the purpose of this thesis:

1. What are the specifics of the NIS model in two Nordic countries studied, i.e. in Sweden and Finland (the main features and peculiarities of NIS in Sweden and Finland has been identified through a comparative analysis of the NIS in these countries with the NIS models in two non-Nordic countries, i.e. in Israel and South Korea)?
2. To what extent has the Nordic model of NIS been implemented in Estonia and what are NIS development challenges there?
3. What are NIS development challenges in Armenia?
4. What lessons can be learned for the development of effective innovation policy in Armenia?

The theoretical basis for this work originates in scientific articles by Lundvall, Freeman, Metcalfe and many others, research and reports of international organizations and national agencies, official documents and information posted on the websites of governmental organizations. Also, semi-structured interviews were conducted in seven private companies in Armenia to compile firm-level innovation data sets.
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**GLOSSARY / ACRONYMS**

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>EIS</td>
<td>European Innovation Scoreboard</td>
</tr>
<tr>
<td>GDP</td>
<td>Gross Domestic Product</td>
</tr>
<tr>
<td>ICT</td>
<td>Information and Communications Technology</td>
</tr>
<tr>
<td>IPR</td>
<td>Intellectual Property Rights</td>
</tr>
<tr>
<td>KAM</td>
<td>Knowledge Assessment Methodology</td>
</tr>
<tr>
<td>NIS</td>
<td>National Innovation System</td>
</tr>
<tr>
<td>R&amp;D</td>
<td>Research and Development</td>
</tr>
<tr>
<td>RTD</td>
<td>Research and Technology Development</td>
</tr>
<tr>
<td>S&amp;E</td>
<td>Science and Engineering</td>
</tr>
<tr>
<td>SME</td>
<td>Small and Medium size enterprises</td>
</tr>
<tr>
<td>USPTO</td>
<td>United States Patent and Trademark Office</td>
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1 CHAPTER ONE - INTRODUCTION

1.1 Context and Motivation

Armenia has achieved significant progress in terms of improved macroeconomic and business conditions and its economic growth has been exceptionally high during the last decade. However, its growth rate extensively depends on external factors such as remittances and assistance from international donor and financial organizations (EV Research Center, 2008).

During the first decade of independence, Armenian government paid little attention to its role as of a main body capable of stimulating and coordinating development of the National Innovation System (NIS) and its different components. Emergence of R&D and innovation policies became noticeable only in the mid 2000s. Today, Armenian policy makers realized that to maintain its high rates of growth, Armenia should adopt an economic development-focused strategy (EV Research Center, 2008).

The concept of NIS is a relatively new perspective on economic policy where innovation and learning are seen as important processes behind economic growth and welfare. The concept was coined at the beginning of the 1980s, and today it is widely diffused among policy makers in many countries, including the biggest economies in the world such as the USA, Japan, Russia, Brazil, South Africa, China and India, as well as in many small countries. Both policy makers at the national level and experts in international organizations for economic cooperation such as OECD, Unctad, the World Bank and the EU Commission have adopted the concept (Lundvall, 2007). The Armenian policy makers consider that the experience of other nations in the creation and development of NIS will be useful for the development of Armenian NIS.

In January 2005, the government approved the concept on innovation activity in the Republic of Armenia. The main aim of this document was to formulate general approaches and principles of the state policy which are directed at the consistent creation and development of NIS together with its basic elements and infrastructure, capable of ensuring sustainable development of the country and increasing its competitiveness as well as creating a favorable innovation environment for international economic co-operation. Based on this concept, the government approved the action plan 2005-2010 in November 2005, directed at the creation and development of an innovation system in Armenia which proposes around 20 measures to be implemented during the stated period (incrEAST, Research Policy in Armenia, http://www.increast.eu/en/143.php , last visited: May 2009). One of measures of the above mentioned action plan is: Implementation of a project on study and benchmarking of best practice and international experience (Europe, USA, CIS, etc.) on innovation management and development of innovation infrastructure (Arzumanyan, 2007).

The issues, such as which model for the key organizations carrying out the science and technology policy would be suitable for Armenia and how the experience of different countries could be useful in this regard, are widely being discussed in different circles in Armenia. This thesis work attempts to answer some of them. It aims to study the experience of Sweden and Finland on innovation management and development of innovation infrastructure and to conclude what lessons can be learned for the development of effective innovation policy in Armenia.

The objective of this research is to study the NIS in Nordic countries, specifically in Sweden and Finland, conduct comparative analysis of the Nordic model of NIS with the NIS models in Israel and South Korea, investigate implementation of the Nordic model of NIS in transition economies
in the case of Estonia, and make conclusion on what lessons can be learned for the development of effective innovation policy in Armenia. This study will be of interest to policy makers, businesses and institutions engaged in R&D activities.

1.2 Purpose and Scope of the Thesis

The purpose of this work is to identify specifics of the NIS model in two Nordic countries, namely in Sweden and Finland, and NIS development challenges in Armenia in order to find out whether the Nordic model is suitable for being implemented in Armenia. In identifying these specifics and challenges, a more general goal is also pursued: to increase general understanding of NIS concept, to examine key elements of NIS model and the NIS impact on economic performance.

In order to investigate the NIS model in two Nordic countries, namely in Sweden and Finland, and identify its specifics, a comparative analysis of the Nordic model of NIS with the NIS models in Israel and South Korea has been conducted. As the experience of implementation of the Nordic model of NIS in other transition economies could be interesting and helpful for the NIS development in Armenia, the case of Estonia has been considered to find out how the Nordic model has been applied there. And finally, the objective of the case study has been to investigate the current situation of NIS in Armenia in order to conclude whether the Nordic model is suitable for being implemented in Armenia and what lessons can be learned for the development of effective innovation policy here.

The research questions to support the purpose of this thesis are:

1. What are the specifics of the NIS model in two Nordic countries studied, i.e. in Sweden and Finland (the main features and peculiarities of NIS in Sweden and Finland has been identified through a comparative analysis of the NIS in these countries with the NIS models in two non-Nordic countries, i.e. in Israel and South Korea)?

2. To what extent has the Nordic model of NIS been implemented in Estonia and what are NIS development challenges there?

3. What are NIS development challenges in Armenia?

4. What lessons can be learned for the development of effective innovation policy in Armenia?

The research questions have been formulated based on the purpose of this thesis. A comparative analysis has been chosen as a suitable tool to identify the specifics of NIS in Sweden and Finland as it helps to have a better understanding of the situation of NIS in Sweden and Finland through comparison of their NIS key elements with NIS key elements in other countries, particularly non-Nordic countries. The same objective could be obtained by considering only the NIS in Sweden and Finland, but in this case it would not be clear what is practiced in other countries too and what is more specific for Sweden and Finland. To some extent, it was my own preference as I was guided by the logic that “everything is learned through comparison” and that observing comparable objects or phenomena is one of the most acceptable methods to get a full picture and to judge about things. In my opinion the method selected for this work has made the results of the analysis more complete and comprehensive.

On the other hand, as it was stated in Section 1.1 the motivation for the thesis has been the fact that today in Armenia we try to study and benchmark best practice and international experience of other countries on innovation management and development of innovation infrastructure (Section 1.1). This has also influenced the choice of countries and methods: the Nordic model of NIS is one of the future scenarios that is being discussed in Armenia now, and other countries
chosen – Israel and South Korea are also exemplary in this regard. That is why I considered that conducting a comparative analysis of NIS in Sweden and Finland with Israel and South Korea both serves the overall purpose of the thesis and makes it more extensive.

I also believe that studying the experience of other transition economies in this field has been relevant to the topic. Estonia has been chosen for this purpose as Armenia and Estonia once were parts of a single country, and now they both are in the transition period (of course, it should be mentioned that the transition processes have been less painful in Estonia than in Armenia). If Armenia is to implement the Nordic model of NIS, it should consider the experience of other transition economies. In this regard, Estonia suits very well and the initial steps it has undertaken and the progress it has had will be useful for the development of NIS in Armenia.
2 CHAPTER TWO - METHODS

2.1 Introduction to Methods

This thesis has combined works of a number of scholars, such as Lundvall, Freeman, Metcalfe and many others, as well as research and reports of different international organizations, such as OECD, the EU Commission, and national agencies responsible for implementation of innovation policy, such as VINNOVA, TEKES, and others. Based upon the listed material, the concept of NIS and different models to measure NIS are presented in order to get a deeper understanding of the concept, NIS key elements, their interaction and impact on economic performance.

The theoretical part is followed by a comparative analysis of the NIS of Sweden, Finland, Israel, South Korea and Estonia, from grassroots to the current challenges. For each country studied, an overview of the NIS is presented that helps to get an overall picture of the NIS in a corresponding country. Based on the theoretical part and comparative analysis, specifics of the Nordic model of NIS are defined, as well as an attempt is made to assess how successful it has been implemented in Estonia.

Finally, the current situation of the NIS in Armenia is considered. Along with the above-mentioned methods for analyzing NIS that are based on secondary data, personal interviews were conducted with representatives of seven private companies of different sizes and specializations. The purpose of the conducted interviews was to capture information about the factors affecting the propensity of firms to innovate, cooperation of firms with each other and with academia/government, information about human resources and how knowledge creation and distribution are proceeding at the level of the individual firms. The interviews conducted were semi-structured and the compiled firm-level innovation data was used for qualitative analysis.

Based on the theoretical framework, the analysis of secondary data and the qualitative analysis of the interview results, an attempt is made to get an overall picture of the current situation of the NIS in Armenia. In the end, conclusions are made on how the Nordic model of NIS could work in Armenia and what lessons can be learned for the development of effective innovation policy here.

2.2 Method for Theoretical Part

The theoretical part of this work provides an insight into the NIS concept, discusses NIS key elements, different models to measure NIS and the NIS role in economic performance. The theoretical basis for this work originates in scientific articles on the NIS concept and research and reports of such international organizations as OECD, the EU Commission, and national agencies responsible for implementation of innovation policy, such as VINNOVA, TEKES, and others.

2.3 Method for Comparative Analysis of NIS Models

The theoretical part is followed by a comparative analysis of the NIS of Sweden, Finland, Israel, South Korea and Estonia, from grassroots to the current challenges. For each country studied, an overview of the NIS is presented that helps to get an overall picture of the NIS in a
corresponding country. Also, Tables 7-12 have been constructed that are presented in Appendix A with a detailed description of key elements of NIS in a corresponding country. The framework employed to construct the tables combines some features of the Triple Helix model (Etzkowitz and Leydesdorff, 2000, see Figure 2 in Section 3.1.2), the Chang and Shih model (Chang and Shih, 2003) (a more detailed description of the Chang and Shih model is presented in Section 3.1.2). Also, it includes some of the key elements of NIS model from Figure 1 in Section 3.1.2. The model has been adapted by Sevak Hovhannisyan from Economy and Values Research Center (Armenia) and will be used to assess the NIS in Armenia in the 2nd Armenian National Competitiveness Report (forthcoming). The framework used in the Tables 7-12 is described in Table 1.

### Table 1: Key elements of National Innovation System

<table>
<thead>
<tr>
<th>Human Capital Supply</th>
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<tbody>
<tr>
<td>University</td>
</tr>
<tr>
<td>Work force mobility</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Infrastructure for performing R&amp;D</th>
</tr>
</thead>
<tbody>
<tr>
<td>University</td>
</tr>
<tr>
<td>Public or semipublic research institutes/labs</td>
</tr>
<tr>
<td>Techno parks, incubators</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Policy and regulatory framework</th>
</tr>
</thead>
<tbody>
<tr>
<td>Innovation strategy and policy</td>
</tr>
<tr>
<td>Innovation promotion and incentives</td>
</tr>
<tr>
<td>Government procurement of technology products</td>
</tr>
<tr>
<td>Taxation</td>
</tr>
<tr>
<td>State institutions regulating/coordinating innovation</td>
</tr>
<tr>
<td>Legal system, e.g. IPR protection</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>R&amp;D funding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private companies and Business Expenditure on R&amp;D</td>
</tr>
<tr>
<td>Public funding</td>
</tr>
<tr>
<td>Angel &amp; Venture Capital</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Linkages and Networking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Networking</td>
</tr>
<tr>
<td>University-private business partnerships</td>
</tr>
<tr>
<td>Research institute-private business partnerships</td>
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</tbody>
</table>

The model used consists of the following categories: (1) human capital supply, (2) infrastructure for performing R&D, (3) policy and regulatory framework, (4) R&D funding and (5) linkages and networking. In order to capture more detailed information, these categories are divided into subcategories: (1) university and work force mobility; (2) university, public or semipublic research institutes/labs and techno parks, incubators; (3) innovation strategy and policy, innovation promotion and incentives, government procurement of technology products, taxation, state institutions regulating/coordinating innovation, legal system, e.g. IPR protection; (4) private companies and business expenditure on R&D, public funding, angel & venture capital; (5)
networking, university-private business partnerships, research institute-private business partnerships. The framework is intended to capture the structure and performance of NIS. Also, it helps to present innovation policy programs and projects in detail, which is useful for policy-makers in studying and developing innovation policy programs.

While analyzing the NIS of the countries under study, along with scientific articles, research and reports, official documents and information posted on the websites of Ministries and governmental organizations of the above-mentioned countries have been used to reveal the real situation of NIS in these countries.

Based on the theoretical part and comparative analysis, specifics of the Nordic model of NIS are defined, as well as an attempt is made to assess how successful it has been implemented in Estonia.

Finally, the current situation of the NIS in Armenia is considered. Based on the theoretical framework, the analysis of secondary data and the qualitative analysis of the interview results, an attempt is made to get an overall picture of the current situation of the NIS in Armenia. In the end, conclusions are made on how the Nordic model of NIS could work in Armenia.

2.4 Semi-structured Interviews for Qualitative Analysis

Along with the above mentioned methods for NIS analysis that are based on secondary data, personal interviews were conducted with representatives of seven private companies of different sizes and specializations. The interviews conducted were semi-structured ones aiming to compile firm-level innovation data sets for qualitative analysis. The purpose of my study was to capture information about the factors affecting the propensity of firms to innovate, cooperation of firms with each other and with academia/government, information about human resources and how knowledge creation and distribution are proceeding at the level of the individual firms. Therefore, qualitative method is used, because it “is suitable for studying organizations, groups and individuals; can provide intricate details and understanding; and offers a far more precise way to assess causality in organizational affairs” (Ghauri and Gronhaug, 2005). Also, “typical examples of qualitative research are research problems where we want to uncover and understand a phenomenon about which little is known” (Ghauri, 2004; Marshan-Piekkari and Welch, 2004).

While selecting companies for study, I tried to include companies of all sizes and engaged in different kinds of activities. The list of the studied companies is as follows:

1) 2 large firm – a chain of “Star” supermarkets, and Yerevan Brandy Company, a company engaged in the production of brandy and owned by a foreign corporation,
2) 2 medium companies - a chain of bookstores and a chain of cafés.
3) 3 small companies – two of them are IT companies (“PUL” and “Azea”) and one firm is financial intermediary (“Cascade Investments”).

During these semi-structured interviews, along with a block of open-ended questions (see the list of open-ended questions in Appendix B), I asked additional unplanned questions that arose while conducting an interview. The issues covered in the questions related to different aspects of a company’s activity. To give a respondent an opportunity to get prepared for an interview and, if needed, to collect information (very often from different departments), I sent my questions by email to the companies and people I intended to meet with. Along with the questions, I wrote
about the purpose and objectives of the study, the benefits it could bring to businesses operating in Armenia, how much time the interview would take and asked them for a personal meeting.

The semi-structured interviews were conducted with 12 people representing the above-mentioned companies as follows:

1) “Star” supermarkets – Gurgen Narimanyan (CFO) and Vanuhi Qerobyan (Marketing Department Chief Specialist),
2) Yerevan Brandy Company – Ignati Arakelyan (Finance and Administrative Director), Garegin Manvelyan (Purchase Manager), Armine Bibilyan (Human Resources Manager),
3) “Art-bridge” bookstores – Shaqeh Havan-Karapetian (Director-owner) and Nvard Manvelyan (Senior Accountant),
4) “Art-bridge” cafés – Shaqeh Havan-Karapetian (Director-owner) (these two “Art-bridge” chains are separate businesses owned by the same person),
5) “PUL” – Hrach Makaryan (Director) and Vardan Movsesyan (Deputy Director),
6) “Azea” – Zaven Azatyan (President-owner),
7) “Cascade Investments” - Yeghishe Kerobyan (Portfolio Manager).

As Ghauri recommends, I conducted a pilot interview and found out that the respondent complained that some questions were too complicated. Therefore, the initial interview questions were paraphrased, simplified and made shorter.

At the beginning of the interview, I asked the interviewees to tell about the company they work for, their priorities and products, etc. If the respondent was an entrepreneur, I also asked why she/he decided to open such a business, etc. Along with the previously-prepared open-ended questions, additional spontaneous questions were given that helped to dig further into the topic. In the end of the interview, I asked whether the interviewee was interested in the final report or the thesis work where it would be used, and whether she/he didn’t mind my calling if a question or two arose later. Overall, the interviews lasted about an hour (as it is recommended in the Ghauri textbook).
3 CHAPTER THREE – LITERATURE REVIEW

3.1 National Innovation Systems

3.1.1 The Origin and Definition of the National Innovation System Concept

Knowledge and innovation are key factors for competitiveness and growth in the modern economy. Therefore, a new approach on economic policy has gained increased visibility in recent years where innovation and learning are seen as important processes behind economic growth and welfare. It is believed that the concept of the National Innovation System was “intended to help develop an alternative analytical framework to standard economics and to criticize its neglect of dynamic processes related to innovation and learning when analyzing economic growth and economic development” (Lundvall, 2007).

There are different definitions of the NIS concept; furthermore, different scholars mean different things when referring to this concept. Metcalfe (2008) considered that the definition given by Niosi, Saviotti, Bellon, and Crow (1993, p.212) represents a good synthetic summary of the prevailing definitions:

the system of interacting private and public firms (either large or small), universities and government agencies, aiming at the production of science and technology within national borders. Interaction among those units may be technical, commercial, legal, social and financial, in as much as the goal of the interaction is the development, protection, financing or regulation of new science and technology.

Lundval (1992), for example, argued that there can be both a broad definition, and a narrow one. The innovation system in the narrow sense is when the NSI concept is used as a follow-up and broadening of earlier analyses of national science systems and national technology policies (Lundvall, 2004, p. 534).

And the “broader” definition is when

innovation is defined as a continuous cumulative process involving not only radical and incremental innovation but also the diffusion, absorption and use of innovation and … when the major source of innovation is not necessarily science. Innovation is seen as reflecting interactive learning taking place in connection with ongoing activities in production and sales (Lundvall, 2004, p. 534).

The concept of the NIS emerged in the 1980s to explain the differences in innovative performances of industrialized countries (Freeman, 1995; Lundvall, 1992; Nelson, 1993). Scholars argued that differences in economic and technological performance across national states were due to the combinations of institutions involved – and their interactions – which determined the processes of accumulation of capital and technology (Metcalfe, 2008). That is to say, variation in innovative performance of nations depended on “institutional differences in the mode of importing, improving, developing and diffusing new technologies, products and processes” (Freeman, 1995, p. 20). Metcalfe also mentioned that there is a danger to confuse invention systems with innovation systems and miss out the complementary economic processes required to turn invention into innovation and subsequent diffusion (Metcalfe, 2008).
Freeman traced some of the basic ideas behind the NIS concept back to Friedrich List (List, 1841-1959). His concept “national systems of production” took into account a wide set of national institutions, including those engaged in education and training, as well as infrastructure such as networks for transportation of people and commodities (Freeman, 1995). List argued that the focus should be on the development of productive forces rather than on allocation issues. List opposed Adam Smith’s (1723-1790) approach which favored a cosmopolitan model of economics, whereby the acting of participants and the functioning of the markets are dependent only on generally accepted laws. List pointed out the revenues of the nations depended mainly on the “accumulation of all discoveries, inventions, improvements, perfections and exertions of all generations which have lived before us” (Freeman, 1995, p. 6). Finally, List stressed the interdependence of intangible and tangible investments and the importance of an active interventionist economic policy in order to promote long-term development (Freeman, 2004).

In his publications, Freeman studied some examples of major shifts in world technological and trade leadership, namely attempted to explain Germany’s dominance over England in the 3rd Kondratiev cycle (approximately lasting from 1890s to 1940s), and then he considered the case of Japan, encouraged by its post-war unprecedented economic growth and policy.

In parallel with European scholars, the innovation system concept was also developed in the USA in the 1980s. Nelson and other US scholars worked on comparing university-industry links in the USA with patterns in Japan and Europe (Nelson, 1988; Lundvall, 2004). Lundvall argued that Nelson’s ideas constituted a micro-foundation for the innovation systems concept claiming that “markets are mixed with organizational elements and these elements differ between national and regional systems” (Nelson 1988, 1993; Lundvall, 2007).

Further to Nelson’s opinion that durable relationships are necessary to be established in markets between parties involved and that these parties are required to invest in codes and channels of information, a series of studies showed that in different nations there are disparate possibilities for establishing organized markets. As a result of this user-producer interaction analysis, it was concluded that innovation is an interactive process. Thus, Kline and Rosenberg (1986) developed “the chain-linked model” which was another important step toward the idea of NIS (Lundvall, 2007).

The rate of diffusion of the NIS concept is impressive. Today, it serves as a tool for experts in international organizations for economic cooperation, such as OECD, UNCTAD, the World Bank and the EU Commission. Also, it has been diffused among policy makers in many countries. This growing interest in innovation can partially be explained by a shift in economic policy orientation in many countries as a result of the traumatic experienced associated by hyperinflation and currency instability in the 20th century when the economic policy has focused on macroeconomic stability as a guarantor for growth and prosperity. As a result, at present microeconomic conditions, which imply the ability of individuals and organizations to generate, access and utilize knowledge and information, are also seen to be crucial for growth and prosperity (Serger, Hansson, 2004).

To sum up, as “the most important resource in the current economy was knowledge and the most important process was learning” (Lundvall, 2007), policy makers around the world are studying innovation systems and searching the ways to create conditions conducive to the generation and diffusion of innovation.
3.1.2 Measuring the National Innovation System

Based on the innovation system approach, innovation policy is a horizontal policy encompassing a wide range of areas and instruments and cutting across traditional policy domains. The following areas should be mentioned in this context: public research funding, industrial R&D support, patent legislation, ICT infrastructure and deployment, education and training, policy frameworks for networks and clustering, taxation, social policies, etc. (Serger, Hansson, 2004). Figure 1 represents multiple actors and their interactions in the innovation system model.

Figure 1: Innovation System Model (Source: Arnold et. al., 2003)

In Europe, the primary instrument for measuring innovative strength is the Trend Chart on Innovation in Europe. One component of the Trend Chart is the European Innovation Scoreboard (EIS) which is an annual presentation of quantitative data in four categories: human resources for innovation; the creation of new knowledge; the transmission and application of knowledge; and innovation finance, outputs and markets. The Scoreboard tracks 17 main indicators for all of the 25 member states, 3 candidate countries (Bulgaria, Romania, Turkey), 3 associate countries (Iceland, Norway, Switzerland), the US and Japan (Serger, Hansson, 2004).
In addition to the EIS, there are a number of sources measuring innovation globally:

- The OECD’s *Science, Technology and Industry Scoreboard* measures over 200 indicators in its member countries.
- The World Bank’s *Knowledge Assessment Methodology* (KAM) consists of a set of 76 structural and qualitative variables. The KAM compares indicators for a group of 121 countries, including most of the developed OECD economies and about 90 developing countries.
- The World Economic Forum’s *Global Competitiveness Report* presents two overall rankings for 102 countries: growth competitiveness and microeconomic competitiveness.

The Table 2 represents a summary of the main indicators for both the EIS and KAM (Serger, Hansson, 2004).

### Table 2: Innovation Scoreboard Indicators (Source: European Commission and World Bank Knowledge Assessment Methodology)

<table>
<thead>
<tr>
<th>Summary Innovation Index-2 (European Commission)</th>
<th>Basic Knowledge Assessment Scorecard (World Bank)</th>
</tr>
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<tbody>
<tr>
<td>Human resources</td>
<td>Performance indicators</td>
</tr>
<tr>
<td>S&amp;E graduates</td>
<td>Average annual GDP growth</td>
</tr>
<tr>
<td>Population with tertiary education</td>
<td>Human development index</td>
</tr>
<tr>
<td>Participation in lifelong learning</td>
<td>Economic incentive and institutional regime (pillar one)</td>
</tr>
<tr>
<td>Employment in high-tech manufacturing</td>
<td>Tariff and non-tariff barriers</td>
</tr>
<tr>
<td>Employment in high-tech services</td>
<td>Regulatory quality</td>
</tr>
<tr>
<td>Knowledge creation</td>
<td>Rule of law</td>
</tr>
<tr>
<td>Public R&amp;D expenditure</td>
<td>Education and human resources (pillar two)</td>
</tr>
<tr>
<td>Business R&amp;D expenditure</td>
<td>Adult literacy rate</td>
</tr>
<tr>
<td>Innovation finance, output and markets</td>
<td>Secondary enrolment</td>
</tr>
<tr>
<td>Hi-tech venture capital</td>
<td>Tertiary enrolment</td>
</tr>
<tr>
<td>Early stage venture capital</td>
<td>Innovation system (pillar three)</td>
</tr>
<tr>
<td>Internet access/use</td>
<td>Researchers in R&amp;D</td>
</tr>
<tr>
<td>ICT expenditures</td>
<td>Scientific and technical journal articles</td>
</tr>
<tr>
<td>Value-added in manufacturing</td>
<td>Patent applications granted by the USPTO</td>
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<tr>
<td></td>
<td>Information infrastructure (pillar four)</td>
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<tr>
<td></td>
<td>Telephones per 1000 population</td>
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<td></td>
<td>Computers per 1000 population</td>
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<tr>
<td></td>
<td>Internet users per 10,000 population</td>
</tr>
</tbody>
</table>

These benchmarking studies are aimed at identifying “best practice policies” and “best behavior” among the countries under study based on which recommendations are derived for best practice policy. However, no set of indicators can give the full picture of innovation in a country without considering the national context (Serger, Hansson, 2004).

Recently, the “triple-helix” model has been discussed as a tool to understand university-industry-government relations. The “triple-helix” thesis states that the university being a knowledge-producing and disseminating institution can play an enhanced role in innovation system and can
contribute to the development of knowledge in the industrial and commercial sectors (Eriksson, 2005). Thus, realizing the importance of strategic cooperation between three institutional spheres, i.e. public, private and academic, many countries are now trying to attain some form of Triple Helix (or using the terminology of Etzkowitz and Leydesdorff (2000) – Triple Helix III, see Figure 2). Figure 2 represents university-industry-government relations in Triple Helix III.

Figure 2: Triple Helix III (Source: Etzkowitz and Leydesdorff, 2000)

In order to overcome limitations in comparative studies of NIS, descriptive frameworks of NIS were introduced by some scholars. One of such models has been introduced by Chang and Shih (2003) to study the composition and strength of NIS. The model is based on previous work by the OECD (1999) and is made up of six elements to analyze structural specifics of NIS: R&D expenditure, R&D performance, technology policy, human capital development, technology transfer, and the climate for entrepreneurial behavior; and four fundamental groups of indicators to capture the performance of a system: formal and informal cooperation in R&D, measures of the dissemination of innovations, and finally the mobility of the national workforce (Balzat and Hanusch, 2004).

In order to set priorities for innovation policy, governments must be able to measure key elements of innovation system model (see Figure 1) and compare them to appropriate benchmarks. For instance, both the EIS and KAM (see Table 2) present and compare data on most elements of the innovation system model. There are considered indicators such as the level of graduation and literacy rates, number of employees in high-tech industries, R&D expenditures, venture capital market, regulatory quality, results of innovation activity in the form of scientific and technical articles, patent applications, etc. In addition to the listed indicators, descriptive studies observe data on categories such as technology transfer, the climate for entrepreneurial behavior, cooperation in R&D, measures of the dissemination of innovations, mobility, etc. All these areas can be found in the innovation system model presented in Figure 1.
The framework used in this thesis for comparative analysis of NIS in the observed countries combines some features of the Triple Helix model and the Chang and Shih model presented above. Also, it includes some of the key elements of NIS model from Figure 1. The detailed description of the framework employed can be found in Section 2.3.

### 3.2 Sweden

After the Second World War, Sweden had a very competitive system for rather a long period, and its growth was very fast. But gradually, the long-term competitiveness of the Swedish NIS became relatively weak, keeping Sweden for most of the period 1970-2003 far from the top on the OECD rankings in terms of innovation, economic growth and job creation. The main reasons for that were:

- A gradual loss of efficiency in policy environment where the main focus was on the development and growth of large R&D-intensive multinational groups. Though a large volume of R&D activities is still carried out by such groups, their value generation in Sweden has gradually been decreasing.
- The relative lack of strong incentive and support structures for renewal and growth through knowledge-intensive start-ups and SMEs.
- Relatively weak focus on service sector innovation and value added in both the private and public sector. In the private sector, such innovation is closely related to the degree of innovation in SMEs.
- Relatively strong focus on curiosity-driven basic research in the Swedish research system, which has been most beneficial to large knowledge-intensive multinationals, than to other innovation and value-added production in the public and private sectors.
- Deterioration of Swedish human resources sustainability in the past decade (VINNOVA, 2004).

Globalization has reduced restriction on the international mobility of goods, services, capital, and labor. As a result, large companies are gradually locating an increasing proportion of their production and research activities abroad, mainly in their own subsidiaries in countries with a high level of expertise but low labor costs, such as China and India. The challenge for companies and regions is to develop knowledge-based production, which requires adjustments in production methods, research and development, education systems, labor market policy, the infrastructure and so on (VINNOVA, 2006 (a)).

Thus, new realities have forced the government to start reforming the system. The changes included a new policy that enables SMEs to increase their innovative abilities and to grow to become more attractive for cooperation both with Swedish and foreign companies, as well as for expanding independently in new global markets. Other major change has been the transformation of the role universities when universities are demanded apart from education and research cooperate with the society to contribute to the development of knowledge in the industrial and commercial sector (VINNOVA, 2006 (a)).

The Swedish NIS is characterized by high spending on R&D as percent of GDP, internationally oriented industrial firms and universities, rapid adoption of new techniques and public research institutes playing a minor role except in the area of defense. Starting in 1988 a large part of the R&D-intensive major companied have merged with or been acquired by foreign firms. The big international companies dominate the R&D-system, whereas SMEs invest very little in R&D. Universities play a major role in the public R&D-system and they have a third task, to cooperate
with companies and society. The Swedish government support of R&D in companies is traditionally very small, except R&D in the military sector (VINNOVA, 2006 (b)).

The main government bodies in charge of the Swedish innovation policy are Ministry of Science and Education, a special agency for coordination and implementation of national innovation policy, VINNOVA, and Swedish Research Council. Figure 3 represents major public R&D-funding organizations in Sweden and their budgets in 2006.

Figure 3: Major public R&D-funding organizations in Sweden (Source: VINNOVA, 2006)

VINNOVA, the Swedish Governmental Agency for Innovation Systems, integrates research development and innovation. In 2006, its budget was 150 M€, excluding administrative expenses, and it was planned that VINNOVA’s funding should increase up to more than 200 M€ by 2008. VINNOVA’s mission is to promote sustainable growth by funding needs-driven research and developing effective innovation systems. VINNOVA focuses on strengthening research cooperation between academia, companies and politics/public sector in the Swedish innovation system. VINNOVA’s main areas of activity include:

- Development of research and innovation strategies for specific fields and sectors in close dialogue with actors in Swedish innovation systems,
- Strategic R&D-programs in six major fields (i.e. Information and Communication Technologies; Services and IT implementation; Biotechnology, Life sciences; Manufacturing and Materials; Transport systems, Automotive; and Working Life Science) usually involving cooperation between universities and companies and other actors,
- Support the building up of strong research and innovation environments (VINN Excellence Centers and other COEs at universities, Regional Innovation Systems under VINN Growth program),
- Strengthening of the functions for commercialization of research at universities,
- Development of the institute sector in Sweden,
- Support for R&D aiming at radical innovations in SMEs,
- Supporting international cooperation,
- Knowledge and research about innovation systems,
- Informing the broader public about research and innovation.
The detailed description of the key elements of NIS of Sweden is presented in Table 7 in Appendix A.

International bodies for economic cooperation and independent research institutes publish rankings of the innovative capacity of different countries based on a number of independent indicators which, however, do not automatically constitute a quality declaration of innovative performance. For instance, such indicators usually include R&D investments as a percentage of GNP, the number of patents registered, the number of scientific articles published, the percentage of the labor force with a higher education and so on. (VINNOVA, 2006 (b))

Sweden has come out best amongst the EU countries with the publication of the 2008 European Innovation Scoreboard (EIS). The study shows that Sweden is the most innovative country and has ranked among the innovative leaders in the EU. Sweden is well ahead in such areas as human resources, R&D investment and efforts to promote innovation in companies. However, some improvements are required in terms of commercialization of innovations. Sweden ranks highest out of the EU countries, but the rate of increase is lower than average for the EU (VINNOVA news, 2009).

In summary, the success of the Swedish NIS is evident, but its strong research and innovation environment should be constantly maintained to be able to generate new goods and services, which in turn will affect growth, employment and welfare.

### 3.3 Finland

Finland was a relatively poor and largely agrarian country until the Second World War. However, following the example of Britain, with support from the government and funded by the capital brought in through exports of forest products, the transformation from an agrarian to an industrial society slowly began. Finland started to catch up with Western Europe in the 1920s and 1930s, largely due to processed forest product exports, technological developments giving rise to labor productivity and favorable international trends (Kuisma, 1999). Finland finally caught up with the most developed countries in the period following post-war reconstruction up until the mid-1970s (Oinas, 2005).

Forestry, forestry machinery and forest consultancy corporations developed high levels of know-how and occupied leading positions in the world market. The forestry corporations had a central role in the development of “Finnish-style capitalism”. The post-war business system remained relatively closed and was characterized by with state-led coordination, long-term investments in heavy industries and reliance on cartels. Until the 1970s, Finnish companies’ international activities consisted mainly of exports (Oinas, 2005).

In the 1980s, there were wide discussions concerning the need for Finland to modernize and transform into an “information society”. This, however, did not happen immediately. The only changes were that the forest companies started to invest in modern machinery and product development, convincing decision-makers that the paper industry was a science-based, high-technology industry (Oinas, 2005).

After the years of rapid growth in the 1980s, the so-called Great Depression in the 1990s, that was a result of a combination of developments in the Finnish and the international political economy, was especially painful for Finland. Deregulation of the financial markets, liberalization of international capital flows, the collapse of the former Soviet Union – the huge
export market for Finland, and eventually a major crisis in the banking sector resulted in the recession in Finland in the early 1990s (Oinas, 2005). The recession was decisive in bringing about a major restructuring of the economy and the configuration of its centrally controlled politico-economic institutions (Oinas, 2005). In consequence, Finland’s business system has become more open, internationalized and vulnerable to international competition. Its strongest companies have learned to compete successfully with foreign rivals and reap the benefits thereof, thereby contributing to the growth of the national economy (Oinas, 2005). Between 1992 and 1996, high-technology industries became the dominant sector in the Finnish economy, and the country became a leading producer in communication technologies, internationally.

Thus, during the first historical transformation Finland became an industrialized country, during the second turned into a world producer of information and communication technologies, and finally, to meet contemporary challenges for the economy and society, Finland was among the first countries to adopt the concept of NIS as a basis for its technology and innovation policy (Oinas, 2005).

After the adoption of the concept of a NIS in the 1990s, key policy reforms included:

- regional innovation policies,
- national cluster programmes,
- technology centers in the regions,
- venture capital funding arranged via Sitra to strengthen the transfer of technology and application of research-based knowledge in new firms,
- science policy strengthened through the Academy of Finland (Lemola, 2001, pp. 46-49).

The key agents implementing science and technology policy are the Science and Technology Council, the coordinating body, bringing together high-level representatives from the government, industry, academia, and labour market organizations, and chaired by the Prime Minister; the Academy of Finland, National Technology Agency of Finland (Tekes), The Finnish National Fund for Research and Development (Sitra), The Technical Research Centre of Finland (VTT), and the universities. The actors of the Finnish Science and Technology System are presented in Figure 4.
In the recent years, the most important qualitative changes in the NIS include the internationalization of R&D through networking, the strengthened regional innovation policy, more efficient commercialization of research output and intensified national network formation through the Tekes technology programmes, the Academy of Finland research programmes, knowledge centers and cluster programmes. (Lemola, 2001) Particularly, Tekes technology programmes drive cooperation between firms, universities and research institutes, potentially including foreign partners (available at www.tekes.fi). Tekes has foreign offices in Beijing, Shanghai, Brussels, Tokyo, San Jose and Washington (Oinas, 2005).

Among successful features of Finland’s innovation system can be mentioned (1) widespread cooperation between Finnish companies and research organizations, (2) well-developed infrastructure for industrial R&D by international comparison, (3) the Finnish research and education system offering advantages over other locations, (4) collaboration between universities, R&D laboratories of large companies such as Nokia or ABB, their suppliers, and start-up firms spinning out from university research (Oinas, 2005).

Another specific feature of the Finnish economy is that R&D investment is concentrated in certain industries, especially electronics, and is dominated by a handful of large domestic multinational companies. For instance, Nokia alone accounts for 45% of all industrial R&D in Finland, and more than 80% of the R&D investment in telecommunication sector. The shares of two traditional industries, the wood processing and the metal industries have decreased up to 16% of industrial R&D. Also, there is a lack of risk capital leading to small number of R&D-oriented start-ups. In addition, the Finnish system remains relatively isolated with small percentage of business R&D funded from abroad and small number of patents involving foreign co-inventors. The government is aware of these pitfalls and launched an Innovation Strategy in
2008 to maintain and strengthen its leading position (OECD, 2008). The model of NIS of Finland is presented in Table 8 in Appendix A.

Finland has consistently ranked at the forefront of innovation investment and performance, and innovation policy is at the heart of public policy. It is the second in the OECD in terms of R&D intensity and the intensity of higher education R&D has doubled over the past 15 years. Since the mid-1990s, the country has systematically outperformed OECD and EU 15 average performance in labor productivity and GDP per capita growth rates. Thus, Finland’s strong performance in both innovation inputs and outputs has been matched by strong economic performance (OECD, 2008).

3.4 Israel

In the 1970s, Israel has seen a rapid development of industrial activities stemming from military industry. Israel’s requirements for defense R&D spending initiated a strong legacy for R&D investment. It’s not surprising that the country’s competitive high-tech industries, such as security, telecommunications, computing, electronics, optical engineering, and partly semiconductor manufacturing, emerged from the defense-related infrastructure. Even today, the link between Israeli defense and high-tech communities is very strong and produces outstanding economic results (Getz and Segal, 2008).

Since the early 1970s, huge efforts have been invested to support small firms and small industries directly in their research. As a result, a considerable amount of research has been conducted by small firms, leading to new ideas many of which became the basis for start-ups (Getz and Segal, 2008).

The 1980s and more the 1990s have changed the composition of the Israeli economy in general and more specifically the composition of the industry. The high-tech became the leading sector in the industry, followed in the late 1990s by the appearance of new sectors – the bio-tech, and related industries. The rise of the start-ups became evident. The changes included internationalization of Israeli firms and the increase in total R&D activity in the industrial sector. At the same time the chief scientist office (CSO) of the Ministry of Industry and Trade established the technology incubators program. In addition to the new firms established under the different tools of the CSO, development centers of multi-national firms were established: Intel, Motorola, IBM, Applied Materials, Converse, and others. On the other hand, due to the immigration of highly educated workforce from the former Soviet Union, the percentage of technologically oriented workers in society became the highest in the world. Thus, Israel turned into a country specialized in development and technology based industries (Porath, 2006).

In the early 1990s, the government initiated several programs to support and offer entrepreneurs an opportunity to develop their technological ideas and set up new businesses in order to commercialize them. The most vivid examples of these programs are the technological incubators and Yozma. The technological incubators help entrepreneurs at the earliest stages of technological innovation to implement their ideas by developing them into exportable commercial products and assist in forming productive business ventures. The technological incubators share a large portion of the risk at the early stage by providing entrepreneurs with financial resources, tools, guidance, administrative assistance and premises, so that entrepreneurs could turn their abstract ideas into feasible and competitive products. Yozma, an outstandingly successful program, was designed to create a local VC industry from a very limited base. It established a number of VC funds that were initially funded by the government (originally in 1992, the government invested $100 million in 10 VC firms) and included local and foreign
private investors. Since then, the venture capital market in Israel has developed to include over 100 active funds with over $12 billion (Getz and Segal, 2008).

Today, the main government bodies in charge of Israel’s innovation policy are:
• Ministry of Industry, Trade and Labor (MOIT),
• Ministry of Science and Technology (MOST),
• Ministry of Defense,
• Ministry of National Infrastructures,
• Ministry of Agriculture and Rural Development,
• Ministry of Immigrant Absorption,
• National Council for Civil Research and Development (MOLMOP) headed by the MOST,
• Council of Higher Education headed by the Minister of Education.

Table 9 in Appendix A gives a detailed description of key elements of NIS of Israel.

The role of the Office of the Chief Scientist (OCS) at the MOIT (with a budget of EUR 223 million in 2006 and EUR 219 million in 2007) is to assist in the development of the new technologies in Israel, as a means of fostering the Israeli economy, encouraging technological entrepreneurship, leveraging Israeli science-skilled resources, supporting high added value R&D, enhancing the knowledge base of Israeli high-tech industries, and promoting cooperation in R&D, both nationally and internationally. The OCS has funded one out of five project proposals in recent years. The key elements of Israeli public sector are presented in Figure 5.
The Israeli government and a number of not-for-profit organizations operate research institutes that are aimed at a particular sector. About 9% of the expenditures for civil R&D is allocated to these research institutes. The government funds 75% of the expenditures either directly or indirectly.

The government of Israel has signed a number of bilateral R&D cooperation agreements with foreign governments and the European Union in order to encourage contacts between Israel and foreign companies to facilitate joint ventures in R&D. These cooperation agreements that provide additional institutional and fiscal support are divided to Multi-Lateral Programmes such as the: EU Seventh Framework Programme, (ISERD) EUREKA, CELTIC, (The European Cooperation in Telecommunications) and Bi-lateral programs with Australia, Argentina, Belgium, Britain, Canada, China, Finland, France, Germany, India, Ireland, Italy, Korea, Portugal, Russia, Singapore, Spain, Sweden, The Netherlands, Taiwan, Turkey and several agreements with the United States, (BIRD, USISTF, MIDF).

Basic research is done and funded almost exclusively by the major research universities. The Planning and Budgeting Committee (PBC) funds the researchers at the universities and provides specific funding for basic research, which is diffused through the US National Science Foundation, as well as through 10 fellowship programmes and a joint Israeli-American foundation. In recent years, the Ministry of Science and Technology is funding a programme to
develop more basic research. For example, the ministry also funds nano-technology centres in all the major research universities.

The major government funding agency for the industrial R&D system is the OCS of MOIT. The chief scientist operates through four types of programmes. These are:

- Pre-seed and Seed programmes aimed at young start-ups and entrepreneurs;
- Competitive R&D aimed at individual firms and projects;
- Generic R&D (e.g. the magnet and mini-magnet programmes) aimed at developing an infrastructure for development; and
- Partnership programmes with the bi-national R&D foundations and other agencies. ¹

Israel stands out on a number of innovative indicators. It has the highest R&D intensity in the world reaching 4.65% of GDP which is twice the OECD average of 2.26%. Business R&D expenditure is also higher than in all OECD countries, at 3.64% of GDP. Israel has the fifth highest number of scientific articles per million population. It is also among the leaders in the number of triadic patent families per capita. In addition, Israel has a strong information and communication technology sector which comprises about 20% of total industrial output, 9% of business sector employment, and a large share of the output growth of Israeli industry (OECD, 2008). Israel produces and exports roughly 1% of the global hi-tech production while its population is less than 0.5% of the population of the industrial countries (Agmon and Messica, 2008).

Israel’s innovation system is a key driver of economic growth and competitiveness. The success of the Israeli system is primarily attributable to its strong business sector innovation and entrepreneurial culture, as well as to the instrumental role the government played in financing innovation, especially SMEs, and in providing well-functioning framework for innovation (OECD, 2008).

### 3.5 South Korea

Before the 1990s South Korea’s economic development was characterized by three major elements: the state’s strong leadership, the state-owned banking system, and the dominance of the chaebol (business conglomerates) in the industrial structure (Amsden, 1989; Woo, 1991; Fields, 1995; Kim, 1998; Kong, 2000).

From the 1960s, science and technology have been regarded as one of the important instruments for developing the economy (Kim, 1993; Chung and Lay, 1997). In the second half of the 1960s, institutional framework in the S&T area began to be established, e.g. the foundation of the Korean Institute of Science and Technology (KIST) in 1966, the passing of the S&T Promotion Act in 1967, and the establishment of the Ministry of Science and Technology (MOST) in 1967 for the effective formulation and coordination of S&T policy. In the 1970s, many public and government-sponsored research institutes were established that were crucial to the development of South Korea’s S&T. At the beginning of the 1980s, recognizing the importance of technology Korean enterprises started to establish their own research institutes, so that the number of private research institutes increased dramatically during the 1980s, and industry took up the role of being the major player in the NIS (Chung, 2001, p.101).

The major goal of South Korean S&T policy has always been to contribute to enhancing national competitiveness. As South Korea is a centralized country, its S&T policy has been highly mission-oriented (Chiang, 1991; Branscomb, 1992). Normally, the government set the goal of S&T policy and tried to mobilize major actors to cooperate with each other to attain that goal. Therefore, major R&D activities have been oriented toward development of some key technologies. However, since the end of the 1980s, the government began utilizing diffusion-oriented instruments in which many SMEs are able to actively participate. Since the 1990s, major emphasis has been placed not only on further development of key technologies, but also on welfare technologies, like environmental technologies (Chung, 2001, p. 101).

Between 1948 and 1988, the focus of the state-directed economic policy changed over time from primary import-substituting industrialization (food, beverages, textile, clothing, footwear, cement, light manufacturing), through primary export-oriented industrialization (textiles and apparel, electronics, plywood, chemicals, petroleum, paper, steel production), secondary import-substituting industrialization and secondary export-oriented industrialization (automobiles, shipbuilding, steel and metal products, petrochemicals, electronics, consumer electronics, etc.) (Eriksson, 2005).

In 1993 President Kim Young-Sam implemented a reform programme that was aimed at political democratization and economic liberalization which in fact enhanced the freedom of the market for the chaebols and increased their political power. This neoliberal approach consequently created conditions for the chaebols’ expansion and exacerbated their dept-to-equity ratios. In mid-1997, South Korea’s short-term foreign borrowing rose as high as 300 per cent of Korea’s foreign reserves (Noble and Ravenhill, 2000), and the top 10 chaebols’ debt-to-equity ratio reached as high as 622 per cent on average just before the crisis (Chung and Wang, 2001, p. 75).

It is widely believed that Kim’s liberalization policy brought South Korea into the 1997 financial crisis, due to the lack of corresponding structural and regulatory reforms (Weiss, 2000; Wade and Veneroso, 1998; Chang et al., 1998). The Kim Dae-Jung regime’s post-crisis reforms implemented after 1998, under the supervision of the International Monetary Fund, continued along the lines of President Kim Young-Sam’s neoliberal programs (Hundt, 2005), which included the completion of trade and financial liberalization, privatisation and corporate governance reform and labor-market deregulation. The state’s authority increased while the chaebols’ power decreased in the reform process, due to the widespread blame for the latter’s reckless borrowing and expansionary behaviour that had brought the whole nation into a crisis (Woo-Cumings, 2001; Hundt, 2005). Such ad hoc organizations were established, as the Planning and Budget Commission, the Financial Supervisory Commission and the Korean Asset Management Corporation, to deal with the economic emergency and carry out the reforms (Wang, 2005).

Many chaebols went bankrupt without the state support and were forced to focus on their core businesses. Many banks went bankrupt and were purchased by foreigners. Most importantly, the stock market became heavily penetrated by foreign capital from 1998 onwards. The ratio of stock owned by foreigners, in terms of market capitalization, increased rapidly from 12.3 per cent in 1997 to 40.1 per cent at the end of 2003 (SERI, 2004). The importation of a large amount of foreign capital into the securities market helped the chaebols finance their ambitious domestic and global expansion (Wang, 2005). In addition, the financial liberalization significantly opened up the Korean market to FDI. South Korea also became very active in participating in the international capital market in order to access funds for its enterprises’ global expansion. In 2002 and 2003 it collected US $54.6 and US $63.5 billion, respectively, of which the corporate sector accounted for US $21.3 billion alone in 2003. There figures were the highest among the Asian countries (ADB, 2004, p. 16).
To sum up, the Korean chaebols have transformed themselves from technological followers to technological leaders by taking advantage of scale economies and receiving heavy support from the state for their own R&D and for public R&D that they have included with their own. Although the Korean state has expressed its intention to reduce the chaebols’ influence by promoting IT start-ups and venture capital in the post-crisis era, it has not changed the tendency for the chaebol to dominate the industrial structure (KISDI, 2003). Schumpeterian scale economies have steadily become the dominant production norm in the Korean model.

In 2004, the administrative system for S&T was restructured fundamentally. The Ministry of Science and Technology was elevated to a Deputy Prime Ministry for the effective planning, coordination, and evaluation of S&T innovation-related policies. In addition, the Office of Science and Technology Innovation (OSTI) was created to take responsibility for the allocation of the national R&D budget and for the coordination of S&T human resources policies and regional technology innovation policies (Korean MOST, 2007). Table 10 in Appendix A represents the model of Korean NIS.

Major components of the South Korean innovation system (see Figure 6 below) include the Ministry of Science and Technology (MOST), about 25 government-sponsored research institutes, more than 120 universities and colleges, and most importantly, industrial enterprises (Chung, 2001, p.102).

**Figure 6: South Korean Science and Technology System** (Source: Ministry of Science and Technology of Korea, 2007)

To bring greater coherence to the system, the R&D Total Roadmap has been introduced to set the public research on a strategic path. Korea is also attempting to broaden the spectrum for future growth by funding biotechnology, nanotechnology and other promising areas (OECD, 2008, p. 134).

R&D expenditure has grown rapidly in recent years and Korea is now among the OECD leaders in terms of R&D intensity. The number of researchers is also above the OECD average. On the other hand, outputs from R&D investment indicate a mixed performance. The number of triadic patent families has grown immensely in the last decade and is now well above the OECD average when adjusted for population. However, most of the patents are in low-technology
industries, and there are questions about low levels of patent exploitation (OECD, 2008). In addition, Korea’s services sector accounts for a small share of business R&D and for little in-house product or process innovation. With services now accounting for more than 50% of GDP, improving innovation in services is crucial.

Today, the key challenge for South Korea is to create an innovation system that enables its leading firms to remain at the world technology frontier, while encouraging greater innovation in other sectors of the economy (OECD, 2008, p. 134). Continued support for the development of capabilities and research infrastructure in universities and more strenuous efforts to diffuse knowledge from the public to the private sector will be important.

3.6 Estonia

Estonia is a country undergoing a transition from a strongly government controlled economy into a free market economy. The transition has taken place rapidly. Most of the structures and policy processes have been developed since mid 1990s and are still developing. They have lead to polarization of regional development, labor markets, wage levels, etc. Today there is a drive to link Estonia more strongly to the European context and regulatory framework has been integrated largely with EU regulation. Strongest linkages are to Nordic countries, especially to Finland and Sweden. Selecting to become a free market economy and at the same time a Nordic welfare state is a big challenge. The society and economy are currently struggling with several major issues related to this transformation (Romanainen, 2001).

Estonian economy has opened up relatively quickly, as the government has privatized and liberalized markets. Domestic markets are small and have internationalized fast through foreign direct investments and foreign trade. Thus, product markets are mostly open and competitive. Financial markets are still quite underdeveloped and mainly controlled by the banks. The size of manufacturing industry is relatively small. Services play an important role in economic development (Romanainen, 2001).

The Estonian industry is mostly low value added manufacturing. Although especially exports are dominated by high-tech and medium high-tech industries, most companies are subcontractors or in contract manufacturing. Larger part of the industry is foreign owned. There are only a few successful companies operating in international markets. Partly because of foreign ownership, many of the companies have stronger linkages outside than inside Estonia (Romanainen, 2001). This is also one of the reasons why networking between companies and between companies and research organizations in Estonia is not very common.

According to the recent report of Estonian Development Fund, Estonian economic structure does not resemble a contemporary knowledge-based economy and is built up on cheap labor and services. In Estonia, both the production structure and the technology used is more oriented towards blue collars (i.e. skilled workers of agriculture and fisheries, skilled workers and craftsmen, equipment and machine operators, unskilled workers) in comparison to the European average (Estonian Development Fund, 2008).

The same study revealed that to catch up with the level of productivity in the developed industrial countries, Estonia should not only raise the technological level of enterprises and increase the so-called technical productivity, but should also change the structure of industry towards increasing the relative importance of sub-branches with higher productivity (e.g. production of precision instruments, medical equipment, sophisticated electronic components
and equipment). Also, the importance of knowledge-intensive services in the economy must increase. No shift towards the innovation supporting environment has been recorded, so economic policy instruments are required to influence the process (Estonian Development Fund, 2008).

Overall and private R&D investments are at a relatively low level. Public sector provides most of the national R&D investment. Although the share of R&D financed by the business enterprise sector has grown in Estonia rather rapidly in recent years, industrial R&D investment still remain modest compared to EU.

The Estonian NIS starts with the parliament and government, which hold the legislative and executive functions respectively. Education and science policies fall under the Ministry of Education and Research, while innovation and technology policies fall under the Ministry of Economic Affairs and Communications. The Research and Development Council (RDC, re-launched in 2002) is an advisory body to the government on issues regarding research and development. The Council is chaired by the Prime Minister and comprises representatives of the research institutions and economic community, and ex officio members from the government. The members of the R&D Council are nominated by the government for up to three years. The daily work of the RDC is split into two sub-commissions: one in the Ministry of Education and responsible for research-related issues, and one in the Ministry of Economic Affairs and responsible for innovation policy development. Within the Ministry of Economic Affairs, the Innovation Policy Committee prepares documents shaping the innovation policy of Estonia. The innovation policy executing body is the Foundation Enterprise Estonia (EAS) launched in October 2003 and encompassing five organizations: Estonian Technology Agency, Estonian Export Agency, Estonian Investment Agency, Regional Development Agency, and the Tourism Agency. The EAS is responsible for implementing national innovation policy by providing financing for selected projects and technology programmes, and by launching and coordinating targeted supportive activities for innovation (Serger, Hansson, 2004). Figure 7 below presents the structure of the NIS in Estonia.
The most important policy documents are the research and development strategy *Knowledge-Based Estonia* (2007-2013), and the SME development strategy *Enterprising Estonia*. Key priorities include: the feasibility of setting-up a government venture capital fund, developing cooperation between R&D institutions and enterprises, enhancing enterprise support structures (including credit guarantees), assessing industrial property rights, and realizing an industrial design programme to enhance the role of design for increasing competitiveness and added product values (Serger, Hansson, 2004). Table 1 in Appendix A represents the key elements of Estonian NIS.

To sum up, developments in Estonia since the early 1990s have been marked by different trends. While the short-term economic outlook seems good, there are concerns about the long-term sustainability of the current development pattern of Estonia (Tiits et al., 2008). For Estonia, the 1990s were a “lost decade” in terms of GDP per capita growth, and in fact it has not been catching up with (and even falling behind) industrialized economies.

Changes in industry and services were rapid and often disruptive. Moreover, education and R&D systems were left to their own devices with neither significant structural change nor resources for upgrading (Tiits et al., 2008).

EU accession triggered a very significant policy change in Estonia, which brought innovation policy onto the agenda very strongly. However, the changes were and are often accompanied by relatively little increase in actual funding and, as importantly, by relatively little public attention and discussion of policy strategy. Moreover, the policy analysis and strategic planning capacity at the regional level seem to be even weaker than policy intelligence at the national level (Euro-
There is an opinion that innovation policies need to be strengthened considerably and reinforced by macroeconomic policies that curb current excessive dependence on foreign-financed growth.

### 3.7 Key Observations

The effectiveness of government policy in catalyzing innovation and improving economic performance is mostly determined by national choices of innovation policy governance. The way innovation policy is designed and implemented depends on many different factors: political, historical, social and cultural. These factors in part explain sharp differences between national innovation systems of countries (Serger, Hansson, 2004). All the countries considered in this work have unique profiles and practice different approaches to the common issues.

Sweden was among the first countries where the models for the key organizations carrying out the science and technology policy were traditionally developed. Yet, Finland was the first country that officially adopted the concept of a NIS as a basic category of its science and technology policy (Oinas, 2005). Today, the innovation policy is at the heart of the public policy of these countries and is in state of constant development (see Tables 7 and 8 in Appendix A).

Israel does not pursue an explicit innovation policy, i.e. innovation is encouraged as a by-product of R&D encouragement programs (see Table 9 in Appendix A). In these programs innovation is a paramount criterion, but the objective is to encourage R&D that will lead to manufacture, employment and export. Nevertheless, this model also proves to be successful: Israel stands out on a number of innovation indicators and Israel’s innovation system is a key driver of economic growth and competitiveness. As for South Korea, innovation and creativity has been a policy focus for some time. Various ministries are involved in science, technology and innovation policy. To bring greater coherence to the system, the R&D Total Roadmap has been adopted that seeks to set the public research base on a strategic path (see Table 10 in Appendix A).

In all the countries observed, the Ministries of Trade and Industry and Education and Research are the main government bodies regulating and coordinating innovation policy (see Tables 3-7 in Appendix A). In addition, the Ministry of Finance responsible for the overall government budget allocation plays a considerable role in innovation policy making. Thus, as innovation policy is spread out between traditional ministries which may result in coordination problems.

In some countries, like in Finland, South Korea and Estonia, a council with the Prime Minister at the head is organized for innovation policy-making. Such councils at the highest levels of government, made up of representatives of different competencies from different sectors, are crucial for coordinated and efficient innovation policy-making. They take decisions in prioritized areas bringing together departmental interests (see Tables 8, 10 and 11 in Appendix A).

In Sweden, Finland and Estonia, there is an agency responsible for coordination and implementation of national innovation policy, i.e. VINNOVA in Sweden, the National Technology Agency of Finland (Tekes), and the Foundation Enterprise Estonia (EAS). Such agencies drive cooperation between firms, universities and research institutes and support more efficient commercialization of research output, internationalization of R&D through networking, the strengthened regional innovation policy and intensified national network formation. They promote sustainable economic growth by financing needs-driven R&D and by developing innovation systems. In other words, these agencies are assigned operational responsibility and are important executers of national innovation policy (see Tables 7, 8 and 11 in Appendix A).
But they should not be viewed as the only agents of innovation policy. Innovation policy is a cross-disciplinary policy area that should include multiple stakeholders.

All the countries studied, except Estonia, invest substantial resources in R&D (see Tables 7-11 in Appendix A). In all the countries considered, except Estonia, big international companies dominate the R&D system, whereas SMEs invest very little in R&D. In Estonia, during the period from 1996 to 2004, R&D expenditures have growth continuously in higher education sector, by 15% a year on the average. In 2004, R&D expenditures in higher education sector were 45.5% of total R&D expenditures. Still, in 2005, the R&D expenditures per capita were 95 USD in Estonia, whereas in EU5 – 1231 USD (Estonian Development Fund, 2008). Thus, due to the low level of R&D investments, Estonia appears to clearly lag behind the developed countries (see Table 11 in Appendix A).

Improved supply, use and mobility of human resources is identified as one of innovation policy challenges and addressed in national innovation policy strategies in many countries. As for the countries studied, remarkable features of national innovation systems of Sweden, Finland and Israel are high quality education and relatively high educational level of population (see Tables 7, 8 and 9 in Appendix A). South Korea has taken serious steps in this direction. During the past several decades, the Korean higher education sector has experienced tremendous expansion, but the quality of teaching and research has not improved very much (see Table 10 in Appendix A). Low education expenditures in Estonia explain lack of qualified engineers, insufficient availability of information technology skills and comparatively low share of people with higher education as compared to Sweden and Finland (see Table 11 in Appendix A).

Sweden, Finland, Israel and South Korea boast well-functioning research system (see Tables 7, 8, 9 and 10 in Appendix A). For instance, in Sweden, there are very good industry-science relations, but dominated by larger firms. To strengthen R&D infrastructure and academia – companies – public sector cooperation, VINNOVA conducts a wide range of programs: VITT Excellence Centers at universities, Institute Excellence Centers, Forska&Vax programme for stimulating radical innovation in SMEs, Active Industrial Collaboration project and many others (VINNOVA, 2006 (a)). In Finland, there is an active collaboration between university research, R&D laboratories of large companies such as Nokia or ABB, their suppliers, and start-up firms spinning out from university research. In the regions, 16 knowledge centers were established to channel EU structural funds and to coordinate knowledge creation and diffusion, and regionally distributed technology centers were established via Sitra to strengthen the transfer of technology and application of research-based knowledge in new firms (Lemola, 2001, pp. 46-49). Finland has a well-functioning public research system (e.g. VTT, Finnish Forest Research Institute, etc.), and the intensity of higher education R&D has doubled over the past 15 years (OECD, 2008). While comparing the situation in Sweden and Finland, it should be noted that in Finland research institutes play more active role in R&D, whereas in Sweden, universities are more central in this regard.

In Israel, there are 6 world-class class academic and scientific research campuses, 12 regional R&D centers, 24 technological incubators (see Table 9 in Appendix A). Most government ministries have a chief scientist to encourage the commercialization of science and technology in their respective area of responsibility, and all universities have established Offices of Technology Transfer (OTT) in order to oversee and supervise patent registration and commercialization of new discoveries. The description of a number of programs and projects aimed at improvement of R&D infrastructure in Israel can be found in Table 9 in Appendix A. As for Korea, it has seven regional science R&D complexes that offer excellent R&D infrastructure, including research institutes, universities and industries (see Table 10 in Appendix A). Still, it should be noted that in Korea universities tend to play a minor role in R&D, as they
have historically been teaching institutions (MoST, 2007). Thus, Sweden, Finland, Israel and South Korea have a well-developed research infrastructure and offer a relatively competitive location for R&D. The situation in Estonia is not so optimistic because of low level of research infrastructure (see Table 11 in Appendix A).

As for government procurement of technology products, in Sweden and Finland public procurement is a seldom-used tool for innovation promotion and traditionally government support of R&D in companies was very small, except R&D related to military procurement or via European Space Agency (see Tables 7 and 8 in Appendix A). In Israel, the Israeli Defense Forces is credited for playing a major role in the continuous success of the Israeli high-tech industry, and the army regularly invests large amounts of money in research and development (see Table 9 in Appendix A). In Korea, the government is actively supporting research in different fields: fusion energy, space development, etc. (see Table 10 in Appendix A). As for the Estonian government, there are some projects to be implemented in the future, but at the moment these projects are in the development stage (see Table 11 in Appendix A).

Another important instrument of innovation policy is taxation. In Sweden and Finland, there is traditionally high taxation and rigid salary in international comparison (see Tables 7 and 8 in Appendix A). In Finland, the new innovation strategy calls for creating tax incentives, especially for risk-taking startups and individuals. In Sweden, starting from 2007, the government implements a tax-credit programme in order to support R&D work in SMEs.

In comparison with Sweden and Finland, there is a wide range of tax incentives and customs treaties in Israel, e.g. tax incentives are offered to any investor in an R&D program who is not a shareholder in the company, any enterprise owner who is doing research for the enterprise’s development, etc. (see Table 9 in Appendix A). And the Korean government offers companies several tax benefits such as income tax reduction and corporate tax cuts, e.g. for research and manpower development costs, for goods for industrial technology R&D, etc. (see Table 10 in Appendix A). To adopt similar measures, the Estonian government is planning to analyze the impact of tax incentives and practices of other countries (see Table 11 in Appendix A).

In the both Nordic countries studied, there is limited venture capital for start-ups, though some improvements are being planning in this regard (see Tables 7 and 8 in Appendix A). The Israeli venture capital market is highly developed; an outstandingly successful government program Yozma and very strong links with US capital markets played a crucial role in its creation and development (see Table 9 in Appendix A). In Korea, entrepreneurs also have a steady supply of capital. The history of Korean venture capital industry is traced back to the 1980s when it was created by the Korean government through the formation of the first Venture Capital Company in a special partnership between the state and private firms (see Table 10 in Appendix A). On the contrary, the Estonian venture capital market is still underdeveloped and there are very small venture capital funds (see Table 11 in Appendix A).

And the last point to be mentioned is networking. Development of regional clusters and international networks is viewed as a priority in innovation policy. Though each organized in its unique way to meet the specific needs if the given country, they all serve to the common purpose of helping SMEs, large companies, universities and research institutes to develop critical mass and a better ability to access funds, spread information and knowledge, and reach their innovative and commercial potential.

In Sweden, some of VINNOVA’s programs are aimed at supporting international cooperation (see Table 7 in Appendix A). For instance, in 2005, VINNOVA worked in the biotech field with a focus on international collaboration (VINNOVA, 2006 (a)). On the other hand, the Swedish
economy is strongly internationally linked (VINNNOVA, 2006 (b)). Also, there are well-developed clusters and networks that vary in size - from the automotive industry throughout the country to clusters with a regional profile such as “Robot Valley” and “Telecom City” (VINNNOVA, 2006 (a)). In Finland, the most important qualitative changes in the functioning of the innovation system in the recent years relate to the internationalization of R&D through networking, the strengthened regional innovation policy, more efficient commercialization of research output and intensified national network formation (Lemola, 2001, p.51). In this country, national cluster programmes were coordinated jointly by five ministers (see Table 8 in Appendix A).

In Israel, there are very strong links with capital markets, mainly in the US, and multiple types of agreements for trade and R&D with a number of countries (see Table 9 in Appendix A). And the Israeli defense infrastructure is considered to be the crucible from which Israel’s competitive high-tech industries emerged, such as security, telecommunications, computing, electronics, optical engineering and also aspects of semiconductor manufacturing. Even today, the link between Israeli defense and high-tech communities continues to produce outstanding economic results (Getz and Segal, 2008). As for South Korea, it participates in a number of international programs, e.g. in the international planning and development of the Generation-IV Nuclear Energy Systems; research on fusion energy and joint development of the International Thermonuclear Experimental Reactor project, etc. (see Table 10 in Appendix A). Korea has built strong S&T cooperation base by concluding S&T Cooperation Agreements with 46 nations. In addition, seven special R&D zones have been established with a view to create a world-class innovation cluster through the cultivation of venture businesses and active commercialization of research results (MoST, 2007). Owing to its chaebol-driven industrialization process, Korea has very strong clusters in the field of information and communication technologies and automotive industry (OECD, 2008). In sum, in all the countries under study, except Estonia, there are well-functioning regional and international networks and clusters (see Tables 7-10 in Appendix A).

As for Estonia, it lacks developed enterprise networks and clusters (Estonian Development Fund, 2008) (see Table 11 in Appendix A).

3.8 Summary

The following characteristics of NIS of the considered Nordic countries, i.e. Sweden and Finland, can be derived, based on the results of comparative analysis described in Section 3.7 Key Observations:

1. Innovation policy is at the heart of the public policy of these countries and is in state of constant development,
2. There is an agency responsible for coordination and implementation of national innovation policy, i.e. VINNOVA in Sweden, the National Technology Agency of Finland (Tekes),
3. Substantial R&D investments, big international companies dominate the R&D system, whereas SMEs invest very little in R&D,
4. High quality education and the highest educational level of population,
5. Well-developed research infrastructure and a relatively competitive location for R&D, in Finland research institutes play more active role in R&D system than in Sweden, where universities dominate the public R&D system,
6. Public procurement is a seldom-used tool for innovation promotion and traditionally government support of R&D in companies was very small, except R&D related to military procurement,
7. Traditionally high taxation and rigid salary in international comparison, recently new tax-credit programmes are being implemented in order to support R&D work in SMEs and to create tax incentives, particularly for risk-taking startups and individuals,
8. Limited venture capital for star-ups, though some improvements are planning in this regard,
9. Well-functioning regional and international networks and clusters.

Sweden and Finland are among the innovative leaders in the EU. Their strong performance in both innovation inputs and outputs has been matched by strong economic performance. However, there are areas that require some improvements, such as commercialization of innovations, support for R&D work in SMEs, availability of early stage venture capital, etc. To be able to keep their strong positions in terms of growth, employment and welfare, they should constantly maintain their strong research and innovation environment in order to generate new goods and services. Because of the impressive results, the experience of Sweden and Finland in the NIS development has drawn attention of policy-makers and actors of NIS in other countries.

Also, as it follows from Section 3.7 Key Observations, the characteristics of NIS in Estonia are:

1. Estonian National Innovation System starts with the highest level of government,
2. There is a special agency executing innovation policy - Foundation Enterprise Estonia (EAS),
3. Low education expenses, resulting in low quality education,
4. Low level of research infrastructure, however, R&D expenditures have growth continuously in higher education sector, by 15% a year on the average,
5. Absence of tax incentives,
6. Private sector R&D investments have grown faster than public sector R&D investments. Nevertheless, the share of the private sector in research and development is still twice as low as that in developed countries,
7. The Estonian venture capital market is still small and therefore there are very few venture capital funds, but its development has received much attention over the last few years,
8. Low level of development of enterprise networks and clusters.

Estonia has shown impressive performance in its transition to a market economy, and it stands out among the Baltic countries in terms of economic growth, institutional stability, and sustained improvement in many of the innovation indicators. Being a small country, Estonia has to establish international ties (i.e. trade, FDI, research collaboration, etc.) in order to gain critical mass and ensure economic growth. Such factors that are outside of the national sphere of influence may impede the sustainability of reforms in the long-term.
CHAPTER FOUR - CASE STUDY: ARMENIA

4.1 Collapse of the USSR, transition crisis and stabilization in the 2000s

Armenia was a major scientific and technology center in the former Soviet Union with quite ramified and developed network of research and education institutions distributed among Academic, university and branch/enterprise sectors. Before 1991, Armenia was a key developer, producer and supplier of almost 30 percent of high-tech and electronic equipment for the defense and aerospace of the former Soviet Union.

Immediately following independence, Armenia undertook reforms aimed at establishing a market economy and democratic society. This was a period characterized by dramatic economic decline, disruption of trade, the Nagorno-Karabakh conflict and transportation blockade, shortage of energy, food, and other consumer products, hyperinflation, and high levels of unemployment and poverty. The government governed in “crisis mode”, forced to find quick solutions to urgent, short term problems. “Survival context” of Armenia’s policy resulted in a short-sighted view of policy, a general lack of policy coordination and of an overall strategy toward policy development, as well as lack of understanding of global economic realities and tendencies and lack of due attention to the country’s international competitiveness.

After achieving economic stability and reaching a ceasefire in the Nagorno-Karabakh conflict in the mid 1990s, the nature of Armenia’s policies became more redistributive. Economic decline stopped, positive GDP growth began; there was a recovery of energy supply; trade re-started; inflation was gotten under control and relatively stable exchange rates were achieved. A manageable fiscal deficit was reached. However, unemployment and poverty remained high, with agriculture the major contributor to economic growth. During this period, the major direction of the reforms was the redistribution of the country’s wealth among its citizens. The privatization has been highly inequitable and resulted in the concentration of the country’s productive assets in the hands of a few power groups. The “redistribution context” implied better, but still weak coordination. The state and businesses started to realize that “market forces” by themselves are not a panacea, and that liberalization and privatization alone are far from being enough for establishing a competitive market economy.

Starting at the beginning of this decade, Armenia adopted a poverty reduction approach – “social context”. This period has been characterized by high rates of GDP growth, increasing retail trade, low inflation, and a high rate of export growth, although exports have been of low value-added and low technology intensity. Armenia has expanded its trading partners geographically. Agriculture has gradually decreased in importance due to the recovery of other sectors such as food processing, mining, diamond cutting, and construction, which has become the major contributor to GDP growth. Some niche sectors, such as IT, have become more sophisticated. Armenia’s budgetary mechanisms have become more sophisticated and incorporated a mid term planning horizon. The government initiated a wide range of legislative reforms aimed at ensuring compliance with WTO requirements. There has been dependency of the economy on money transfers from abroad; high and increasing disparities between regions of Armenia.

In 2003, Armenia adopted the Poverty Reduction Strategy Paper (PRSP), which became an overarching strategic document. The PRSP has become a single comprehensive framework that established long term measurable objectives and important linkages between different aspects of social, economic and institutional life. Elements of strategic thinking, better coordination of policies and operations, improved institutional capacities have been introduced. An attempt to set out priorities, such as prioritization of the IT and tourism sectors, have been made. However,
fundamental questions, such as in which sectors Armenia can successfully compete globally, what its value proposition is, or what its competitive strengths and weaknesses are, have not been addressed (EV Center, 2008). It is believed that Armenia will manage to maintain its high rates of growth only if it adopts an economic development-focused strategy.

In the recent years, Armenia did well in the areas of macroeconomic stability, labor market efficiency and security for doing business. Notable efforts have been made aimed at good government dept management, low inflation, facilitating procedures for starting a business, and ensuring security for businesses. Armenia’s highest ranking relates to its liberal foreign trade regime with quite low tariff rates.

However, there are serious shortcomings in a number or areas, especially at the micro-level, which significantly lower Armenia’s competitiveness in the global context and endanger the sustainability of economic development. These weaknesses are caused by general quality of the business environment, especially the financial sector, the lack of judicial independence, the prevalence of favoritism in government decisions, weak performance in higher education and training, low level of innovation. These shortcomings are so numerous that a comprehensive reform of public and private sectors is required, as well as improved operational and strategic performance of private sector.

4.2 Innovation policy in Armenia

During the first decade of independence, Armenian government paid little attention to its role as of a main body capable of stimulating and coordinating development of the NIS and its different components. Consequently, the R&D and education systems were left to their own devices with neither significant structural change, nor resources for upgrading. Emergence of R&D and innovation policies became noticeable only in the mid 2000s.

In January 2005, the government approved the concept on innovation activity in the Republic of Armenia. The main aim of this document was to formulate general approaches and principles of the state policy which are directed at the consistent creation and development of NIS together with its basic elements and infrastructure, capable of ensuring sustainable development of the country and increasing its competitiveness as well as creating a favorable innovation environment for international economic cooperation. Based on this concept, the government approved the action plan 2005-2010 in November 2005, directed at the creation and development of an innovation system in Armenia which proposes around 20 measures to be implemented during the stated period (incrEAST, Research Policy in Armenia, http://www.increast.eu/en/143.php , last visited: May 2009).

The Ministry of Education and Science (MES) is the state body authorized to develop and coordinate S&T policy-making and the Ministry of Trade and Economic Development is responsible for the development and implementation of innovation policy, in co-operation and coordination with other concerned ministries and organizations (see Table 12 for a description of current situation of the key elements of NIS in Armenia). In 2007, to improve policy-making and achieve better coordination in the field of S&T, the State Committee of Science was created to execute an integrated S&T policy. This structure is subordinate to the Ministry of Education and Science, but with wider power of independent activity. The committee is also responsible for the development and implementation of research programmes in the country through three main financing mechanisms: thematic (project-based) financing, basic financing and special purpose projects. The Science and Technology Development Priorities that have been adopted in August 2002 are as follows: Armenian studies, basic research promoting applied research, special-
purpose research, information technologies, advanced technologies (biotechnology, nanotechnology), new energy sources, risk factors and human health, new materials. The current situation of the key elements of NIS in Armenia is presented in Table 12 in Appendix A.

However, innovation policy conceptual and legislative measures need to be supported by adequate concrete actions and programmes. At the moment, they have more declarative and fragmented character and are not supported by adequate financial commitments or tailor-made decisive actions consistent with general economic development trends. During this period, only a small amount of funds were allocated from the state budget for implementing some of the points of the Action Plan particularly for the creation of an information and analytical centre and a research and innovation center for advanced technologies at the Yerevan Physics Institute.

### 4.3 Education and R&D System

The higher education system in Armenia consists of 22 public institutions of higher education (IHE) and over 67 private IHEs. From 2000 on, the system of higher education in the country started to reform itself along the lines of the European models as per the Bologna agreement. The leading universities of Armenia are Yerevan State University, State Engineering University of Armenia, State Medical University, Russian-Armenian State University, American University of Armenia.

Armenian Academy of Sciences (since 1993 - the National Academy of Sciences of the Republic of Armenia) was founded on 25 November 1943 on the basis of the USSR Academy of Sciences Armenian Branch, organized in 1935. The Statute of the National Academy of Sciences adopted by the Parliament in April 2002, states that the Academy is official advisory body of the government in the field of S&T, and coordinates basic research carried out throughout the country. Currently the Academy has 5 scientific Divisions as follows: Division of Mathematical and Technical Sciences, Division of Physics and Astrophysics, Division of Natural Sciences, Division of Chemistry and Earth Sciences, and Division of Armenology and Social Sciences. In 2006 the total number of the Academy staff was 2884.

Many IHEs departments conduct theoretical and applied research. Even though basic science is on the whole advanced in the system of the Academy of Science, the IHEs departments are also engaged in research, albeit to a lesser degree. Research is carried out in the fields of computer aided design, theory of algorithms, discrete mathematics and combinatorics, cognitive algorithms and expert systems, software engineering, networking, distributed processing, pattern recognition, math logic, computational methods and signal processing systems, and others. Generally, in the recent years there was a shift towards applied as opposed to the fundamental research, which raises concerns over the long-term viability of research by universities and research institutions.

Institutions involved in R&D activities are faced with a number of issues, such as weak commercialization mechanisms and modest cooperation between the industry and research organizations. One of the positive examples of increased R&D activity in universities is the University Centers of Excellence Program was launched in 2007 jointly by the National Foundation of Science and Advanced Technologies (NFSAT) and Yerevan State University (YSU) to support the establishment of University Centers of Excellence (UCE) in the basic and/or natural sciences at Yerevan State University.
There are also some successful examples of industry-university cooperation. For instance, in 2004 LEDA Design founded microelectronics department at State Engineering University of Armenia (SEUA), and together with Cadence Design Systems provided 25 million USD worth semiconductor design software and services to the department. Lycos Armenia established in cooperation with Enterprise Incubator Foundation two centers for internet technologies at the SEUA and at the YSU. Students graduating from these departments are employed by these companies (Arzumanyan and Poghosyan, 2007).

National Academy of Sciences (NAS RA) and academic institutes in Armenia are funded through different channels. The first in the line of funding sources is state budget (approximately 34% of the budget funding and 16% of the total funding). The second funding source is the International Scientific and Technological Center (ISTC) established in 1994 with a share of 36% in the grant programmes (from 1996 to 2006 around 120 projects with more than 30 mln. total budget). Then, the National Foundation of Science and Advanced Technologies (NFSAT) comes established in 1997 by the US Civil Research and Development Foundation (CRDF) and Armenian Government. Until 2004, 235 grants with total cost of 4.3 mln USD dollars have been allocated in Armenia through the NFSAT. The American experts state that despite its short-term history this foundation has became serious funding structure in Armenia. Also, Armenian research teams cooperate with the International Association for the promotion of cooperation with scientists from the New Independent States of the former Soviet Union (INTAS). Armenian research organizations received around 0.8 mln Euro within EU 6th Framework program (2002-2006). Other important international source of funding was the NATO Science programme.

In 2005, a comprehensive study\(^2\) was carried out among scientific community in Armenia, aiming to assess current situation of higher education and academic life in Armenia and to find solutions for overcoming the obstacles in this field. The research has not been translated from Armenian, but in my opinion, it reveals some important aspects in this field and is relevant to my thesis work. Here are some results of this study:

1. Diffusion and use of results of scientific research is one of the most important issues, and scientists and staff of universities and research institutes were asked whether they consider that the result of their studies/inventions can be applied in Armenia. 32% of respondents considered that their work results during the last five years can be fully applied in Armenia now, 45.4% find that the results of their research during the last five years can be applied only if the following conditions will be provided: 1) the willingness of the government, 2) cooperation of all interested parties, 3) cooperation with business sector and in the field of biology and chemistry with clinics, 4) an opportunity of presentation of the latest developments in the field to foreign scientists, 5) development of fund-raising capability. Thus, regardless of economic conditions and the amount and quality of professional resources, more than 55% of the obtained results can be applied in the nearest future if obstacles existing in the scientific field and management are solved.

2. Appraisal of individual work has a significant impact on job satisfaction, therefore financial and non-financial job incentives were studied. Both were considered unsatisfactory: 58% of respondents complained of financial incentives, 94.5% of respondents complained of non-financial incentives. Thus, disadvantages of the scope of job and working conditions in the studied institutes and universities are mostly the result of inefficient management. After the collapse of the Soviet Union the management in the field of science has not undergone any improvements and even deteriorated.

3. The analysis of situation of young scientists and their job satisfaction revealed that 1) the problem of demand and supply of higher education system – science is not solved, 2) the

current scientific environment in Armenia, in terms of working conditions, opportunities for professional growth, financial incentives, are not favorable for young scientists.

4. Only 15.8% of the cases of academia — business sector cooperation presented by respondents were indicated as productive. Only about 2% university staff cooperates with private sector companies.

5. Among serious shortcomings revealed are low level of research infrastructure, under-financing of universities, lack of necessary research equipment, low job satisfaction; the latter is very often explained by inefficient management in the field of science.

6. The issues of development of young specialists and better career opportunities are of great importance as level of emigration of young specialists is extremely high. As a result, there is an abnormal aging tendency in the field – the average age of scientists is 67. According to a survey, more than a half of university and R&D staff under the age of 39 consider working conditions unfavorable.

Some additional facts from the above-mentioned report are also included in Table 12.

In brief, during transition period no major policy measures have been undertaken to support R&D infrastructure and education system in Armenia. The number of researchers in the country decreased fourfold during 1990-2006. The education and R&D sectors experienced the longest-lasting effect of the transition in Armenia and were left to their own devices with no significant structural change or resources for upgrading. The link between S&T potential and other sectors of the economy and society have been disrupted. The current situation in this field significantly lowers Armenia’s competitiveness in the global context and endangers the sustainability of economic development.

### 4.4 Business sector

The private sector in Armenia is the main provider of jobs, employing around 80% of the labor force. In 2007, construction accounted for 25.6% of GDP, followed by agriculture (17.4%) and industrial sectors (15.6% of GDP). The main driver of economic growth is the construction sector, which accounted for 32.9% of GDP growth in 2007, then comes agriculture with about 12.5% of the growth and industrial sectors accounting for 4.3%. Financial intermediation and real estate, renting and business activities sectors contributed 8.8% to the GDP growth.

While development of the construction sector can have an important multiplier effect for economic growth in the short-run, it is not exportable and, given the small local market, in the long run is unlikely to maintain its leadership position. Therefore, it is essential that Armenia relies on the promotion and development of export oriented, high value-added sectors in the medium- to long-run (EV Research Center, 2008).

The Information Technologies (IT) industry is one of the most successful and fast-growing sectors in Armenia. Its history goes back to the mid 1950s when several major RTD and semiconductor manufacturing companies were established, which concentrated on industrial and military applications. Presently, the IT sector produces nearly 10% of Armenia’s export and almost 2% of the GDP. The sector is comprised of, by various estimates, around 150 indigenous and foreign companies generating around 90 million USD annually, and employing around 5000 people. The IT industry has been growing at the rate of 15% annually for the last three years. During recent years a number of foreign companies established its presence in Armenia, e.g. Virage Logic International Corp., HPLA, Synopsis, ViaspHERE International, Monterey Arset CJSC, and others. The most widely practiced specializations are web design and development, customized software development and outsourcing, provision of Internet services, and internet applications and e-commerce. The majority of foreign companies are specialized in customized
software development and outsourcing, chip design and testing, and networking systems and communications.

The enterprise R&D sector is not covered by statistical survey and State Statistical Service doesn’t collect data on enterprise/private R&D sector. The study within the framework of the INCO-Copernicus project conducted in May 2000 by the Armenian Sociological Association showed that after the collapse of Soviet Union and industry privatization, the main constraints for Armenian enterprises became the problem of economic survival and production rehabilitation in conditions of deep energetic and economic crisis in the country. This explained the fact that they pay practically no attention to the development and technological research. The 80.8 % of interviewed enterprises answered, that they did not have own R&D activities during past three years. And only 2% answered that they have own R&D activities regularly. But, even those, who had R&D activities, have on average low R&D expenses – in 69.3 % cases the total sum did not exceed 10% of total turnover or overall costs on average which is caused by a number of factors. First, the promotion and development of innovation were out of the government’s policy agenda. In fact, there were insufficient incentives to promote private R&D expenditures and private sector – university cooperation. In addition, Armenian businesses face serious difficulties in having access to loans to undertake upgrading/new productive investment projects, and venture capital to implement risky and/or innovative projects. It is not surprising taking into consideration the fact that Armenia’s performance in terms of domestic credit provided by the banking sector and of interest rate spread is among the worst in transition countries.

Other constraints for business development in Armenia are: 1) transportation, due to the lack of access to the sea and the closure of railway routes connecting Armenia with other countries, which results in costly and limited access to external markets; 2) the poor implementation of laws and unfair practices conducted by regulatory and inspection bodies; 3) the lack of judicial independence; 4) the low level of skills and professionalism of Armenia’s labor force caused by inability of the education system; 5) low quality of demand conditioned by low purchasing power of Armenian consumers; 6) lack of networks of related and supporting industries, 7) “weak” and “unfair” local competition and the dominance of few power groups in the market, and others (EV Center, 2008).

Within this thesis work, semi-structured interviews were conducted in 7 companies of different sizes and specializations, located in Yerevan, Armenia. The purpose of my study was to capture information about the factors affecting the propensity of firms to innovate, cooperation of firms with each other and with academia/government, information about human resources and how knowledge creation and distribution are proceeding at the level of the individual firms, and to learn companies “from inside”. With this in mind, semi-structured interviews were conducted as a tool to compile firm-level innovation data sets for qualitative analysis.

Semi-structured interviews were conducted in the following 7 companies of different sizes and specializations, located in Yerevan, Armenia:

1) 2 large firms – a chain of supermarkets, and a company engaged in the production of brandy owned by a foreign corporation,
2) 2 medium companies - a chain of bookstores and a chain of cafés.
3) 3 small companies – two of them are IT companies and one firm is financial intermediary.

One should take into consideration that due to small number of large firms in Armenia, an average size of a company is smaller than that in Europe. Two large companies are Yerevan Brandy Company (YBC), owned by Pernod Ricard Group (PR), and “Star” supermarkets chain. YBC has only 356 employees, but it was included in this group, because being an affiliate of a
multinational company it actively uses financial and information resources of this corporation, and thus it cannot be compared to other local medium companies in its possibilities and ambition.

Two medium companies are chains of bookstores and of cafés. Finally, three small companies are “PUL”, a local IT company that is engaged in outsourcing and provides services, such as development of new software programs and hardware devices for foreign companies in USA; “Azea”, engaged in software and web application development and maintenance for local and European companies; and “Cascade Investments”, a financial intermediary firm most services of which are rather new for this market because financial sector is still underdeveloped in Armenia. It also cooperates with well-known firms in Europe and USA.

The data on human resources educational level in these companies is presented in Table 3 which is also one of the characteristics of a company.

### Table 3: Human resources education level in the studied companies

<table>
<thead>
<tr>
<th>Education</th>
<th>Large Companies</th>
<th>Medium Companies</th>
<th>Small Companies</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yerevan Brandy Company</td>
<td>Chain of Supermarkets</td>
<td>Chain of Bookstores</td>
</tr>
<tr>
<td>PhD</td>
<td>11</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Master degree</td>
<td>160</td>
<td>301</td>
<td>6</td>
</tr>
<tr>
<td>Bachelor degree</td>
<td>106</td>
<td>386</td>
<td>9</td>
</tr>
<tr>
<td>Vocational education</td>
<td>79</td>
<td>552</td>
<td>15</td>
</tr>
<tr>
<td>Total number of employees</td>
<td>356</td>
<td>1240</td>
<td>30</td>
</tr>
</tbody>
</table>

To understand how innovative the considered companies are, data were collected on the share of new products, new technological processes, and new management (organizational/control) methods in the overall firm’s production/activity in the recent five years in the given large, medium and small companies. The study revealed that in the recent five years the amount of new technological processes applied have been somewhere between 50-60% and new management methods have constituted over 70% of overall activity in both large companies. In fact, the changes have been so numerous that only a couple of examples will be presented here.

One of the examples is that YBC in cooperation with the Institute of Soil implemented a project where the harmful by-products of brandy production – distillers, were processed and used as fertilizers in the regions of Armenia. Another project was replacement of old water pipes by new system, the results were remarkable – unprecedented reduction of water loss, leading to water conservation and reduction of expenses by 800% (and there have been numerous such projects)!

In “Star”, for instance, they have started the production of bread. In Armenia, the bread significantly differs from the bread produced in Europe. “Star” invited professionals from Italy to introduce this new type of bread, purchased new equipment, trained staff, and what is more difficult is trying to introduce this new product for Armenians into the market.

The only, but sharp difference recorded has been the share of new products which constituted a lion share for “Star” (over 70%) and was not recorded for YBC. The latter fact can be explained by their specialization: “Star” has introduced a wide range of new products and services during this period, while YBC sticks to old traditions in the production of brandy which one of its brand attributes.

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3 Factors affecting the propensity of firms to innovate that were included in the block of open-ended questions and on which the semi-structured interviews were built are underlined in the text.
In two medium companies - a chain of bookstores and a chain of cafés - neither novel products, nor new technological processes have been introduced. There was only a slight improvement in the work organization in both firms (about 10% to 20%), due to introduction of new control system in the bookstore and purchase of new equipment in the café’s kitchen.

In the two small companies, “PUL” and “Azea LLC”, the approximate percentage of new introduced products and services has been 70% and 50%-60%, respectively, which can be explained by the nature of these firms. No new technological processes have been applied in “PUL”. “Azea” started using Oracle database-based web applications which has caused changes in the technological processes by 30-40%. Also, it has recently introduced a new bonus system that can be accounted to 10-20% of its overall management methods. No new management (organizational/control) methods have been applied in “PUL”, and in general the management procedures in this company are rather unsophisticated and simple, if any. The share of new products in the third firm has been 10-20% and that of new technological processes - 30-40%, no improvements have been recorded in management methods. New products, or services in case of “Cascade Investments”, are pension fund management, IPO underwriting, etc., and new processes are online trading (by customers), improvement of back office system, automated reporting.

The statistics on the share of new products, new technological processes, and new management (organizational/control) methods in the overall firm’s production/activity in the recent five years for all the companies studied is presented in Table 4. The firms are grouped according to the size and, along with the results for each firm separately, an arithmetic mean is derived for each group of companies: large, medium and small. The above-described data is summarized in Chart 1 that is constructed based on the arithmetic means for all three groups of companies.

Table 4: The share of new products, new technological processes, and new management (organizational/control) methods in the overall firm’s production/activity in the recent five years in large, medium and small companies under study

<table>
<thead>
<tr>
<th>Company size</th>
<th>Large</th>
<th>Medium</th>
<th>Small</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company name</td>
<td>Yerevan Brandy Comp.</td>
<td>Chain of Supermarkets</td>
<td>Arithmetic mean</td>
</tr>
<tr>
<td>Share of new products</td>
<td>0%</td>
<td>70%</td>
<td>35%</td>
</tr>
<tr>
<td>Share of new technological processes</td>
<td>50-60%</td>
<td>50-60%</td>
<td>55%</td>
</tr>
<tr>
<td>Share of new management (organizational/control) methods</td>
<td>70%</td>
<td>70%</td>
<td>70%</td>
</tr>
</tbody>
</table>
Chart 1: The share of new products, new technological processes, and new management (organizational/control) methods in the overall firm’s production/activity in the recent five years in large, medium and small companies under study

<table>
<thead>
<tr>
<th>Companies</th>
<th>large</th>
<th>medium</th>
<th>small</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) new products</td>
<td>35</td>
<td>0</td>
<td>46.7</td>
</tr>
<tr>
<td>b) new technological processes</td>
<td>55</td>
<td>0</td>
<td>23.3</td>
</tr>
<tr>
<td>c) new management (organizational/control) methods</td>
<td>70</td>
<td>15</td>
<td>5</td>
</tr>
</tbody>
</table>

Academic and non-academic resources are prerequisites for information dissemination and, thus, for innovation. In the development of new technological processes, YBC very often uses the results of academic research conducted in the Academy of Agriculture and the Institute of Soil. Another important source for new methods in almost all the fields for YBC is Pernod Ricard Research Center. All other companies studied nearly do not apply the results of academic research. As for non-scientific resources, “Star” actively uses sources in the Commonwealth of Independent States, in Europe, in North America, namely Russian, British, French, German, US and Canadian retail trade networks. Bookstores staffs periodically participate in book fairs in Europe and North America. Recently, they presented books from Armenia (and/or in Armenian) in a book fair in Germany in such a decent way that the Ministry of Culture, representatives of which were present at that event, assigned them the responsibility of representing Armenia in such fairs. “PUL” and “Azea” use internet search engines, and “Cascade Investments” uses Renaissance Capital research data in the CIS and Citi SmithBarney Research, Saxo Bank Research database in Europe and North America.

Certainly, all companies try to create “new” in the hope of benefiting from it. The YBC invests enormously in new technological processes and new management, organizational and control methods, and probably this can explain the fact that it has considerable savings from such innovations – nearly 70% (remember the example of expenses reduction by 800% as a result of replaced pipes). “Star” has had nearly the same percentage of profit and savings which was the result of a significant amount of new products introduced by “Star” in the local market, as well as constant improvement of management and control methods. The savings from new technological processes have been a little modest, though still reducing the expenses by half.

In medium and small companies, even if new products and management methods have been applied, the profits and savings from them have been rather modest - no more than 20%. The only exception was “Cascade Investments”, where they consider that profit from new products has been about 40% and saving from new technological processes up to 20%. Table 5 contains the results for each company studied and arithmetic means for all the groups of companies showing an approximate proportion of profits and savings that the management of the studied companies consider they have from new products, new technological processes, and new management (organizational/control) methods. And the arithmetic means for all three groups of companies are summarized in Chart 2.
Table 5: Benefits from new products, new technological processes, and new management (organizational/control) methods in the course of year in large, medium and small companies under study

<table>
<thead>
<tr>
<th>Company size</th>
<th>Large</th>
<th>Medium</th>
<th>Small</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company name</td>
<td>Yerevan Brandy Comp., Chain of Supermarkets</td>
<td>Chain of Bookstores, Chain of Cafés</td>
<td>“PUL”, “Azea”, “Cascade Investments”</td>
</tr>
<tr>
<td>Share of profit derived from sales of new products</td>
<td>0%</td>
<td>70%</td>
<td>35%</td>
</tr>
<tr>
<td>Share of savings from new technological processes</td>
<td>70%</td>
<td>50%</td>
<td>60%</td>
</tr>
<tr>
<td>Share of savings from new management (organizational / control) methods</td>
<td>70%</td>
<td>70%</td>
<td>70%</td>
</tr>
</tbody>
</table>

Chart 2: Benefits from new products, new technological processes, and new management (organizational/control) methods in the course of year in large, medium and small companies under study

<table>
<thead>
<tr>
<th>Companies</th>
<th>large</th>
<th>medium</th>
<th>small</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) sales of new products</td>
<td>35</td>
<td>0</td>
<td>26.7</td>
</tr>
<tr>
<td>b) savings from new technological processes</td>
<td>60</td>
<td>0</td>
<td>6.7</td>
</tr>
<tr>
<td>c) savings from new management (organizational/control) methods</td>
<td>70</td>
<td>20</td>
<td>6.7</td>
</tr>
</tbody>
</table>

Another important factor is investments in innovation activities. In order to study this factor, the portion of turnover annually spent on activities, such as R&D, training, product design, market exploration, equipment acquisition and tooling-up, work organization in the given large, medium and small organizations has been observed. Annually, the both large companies spend nearly the same portion of turnover (~3%) on training, product design, market exploration, equipment acquisition and tooling-up, and work organization, except that YBC additionally spends 3% on R&D and nearly twice as much is the amount spent on equipment acquisition and tooling-up (6-10% of turnover). YBC boasts the best laboratory equipment in Armenia and industrial research conducted here is unprecedented. The YBC staff has an opportunity to participate in different trainings in PR Training Center in France. As for “Star”, it conducts market research of such a large scale that probably a few companies in Armenia could do, sometimes steps taken by this chain may alter the price of a product throughout the country.
In contrast, medium companies have no R&D activities, and nearly no market research is conducted, or conducted “in-house”, as for instance, in the bookstore studied. A blackboard is hung on the wall and visitors/customers are invited to write their complaints, suggestions, the book they read recently, etc. In medium companies, 4-5% of turnover is annually spent on staff training, up to 10% on equipment, and less than 3% on work organization. Bookstore spends 4-5% for design (interior), and café 10% for the latter.

Similarly, small IT companies also are not engaged in R&D, but IT companies annually spend up to 10% of resources on staff training. In “PUL”, they spend an insignificant sum on product design, market research and work organization (less than 1% of turnover) compared to nearly 10% annually spent on equipment acquisition and tooling-up. “Azea” does not allocate resources for product design, but instead, it pays more attention to market research (~2%), equipment (~10%) and work organization (~10%). In “Cascade Investments” the resources are allocated more evenly, about 3% on R&D, design, market research and work organization and 4-5% on training and equipment. Annual expenses of all the studied companies on R&D, training, product design, market exploration, equipment acquisition, tooling-up, and work organization, as well as arithmetic means for all the groups of companies are presented in Table 6, and then the arithmetic means are summarized in Chart 3.

Table 6: The portion of turnover annually spent on activities, such as R&D, training, product design, market exploration, equipment acquisition and tooling-up, work organization in large, medium and small organizations under study

<table>
<thead>
<tr>
<th>Company size</th>
<th>Large</th>
<th>Medium</th>
<th>Small</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company name</td>
<td>Yerevan Brandy Comp.</td>
<td>Chain of Supermarkets</td>
<td>Chain of Bookstores</td>
</tr>
<tr>
<td>R&amp;D</td>
<td>3%</td>
<td>0%</td>
<td>1.5%</td>
</tr>
<tr>
<td>Training</td>
<td>3%</td>
<td>3%</td>
<td>3%</td>
</tr>
<tr>
<td>Product design</td>
<td>3%</td>
<td>3%</td>
<td>3%</td>
</tr>
<tr>
<td>Market exploration</td>
<td>3%</td>
<td>3%</td>
<td>3%</td>
</tr>
<tr>
<td>Equip. acquisition and tooling-up</td>
<td>6 - 10%</td>
<td>3%</td>
<td>5.5%</td>
</tr>
<tr>
<td>Work organization</td>
<td>3%</td>
<td>3%</td>
<td>3%</td>
</tr>
</tbody>
</table>
One of the most important issues of concern was collaboration of the companies with each other, academia/universities/research institutes or governmental organizations in activities relating to innovation. Some examples of collaboration of YBC with other organizations (e.g. the Institute of Soil, the Academy of Agriculture, and Pernod Ricard Research Center) have been described above. Only “Cascade Investments” out of SMEs considered offers an internship opportunity for students from Yerevan State University and Agribusiness Teaching Center and actively tries to disseminate the professional skills and knowledge its staff possesses.

In response to the question why they do not collaborate with governmental organizations or academia, the respondents in SMEs replied that in some cases there was no need, in others there was no way and very often they had no desire to deal with the government. To the question of whether they know any incentive measures/laws for SMEs, all the representatives of medium and small companies said they didn’t know, even if there were any, they hadn’t inquired about them and had no intention, “We are glad we are here, working, and haven’t heard of the state, we rather not”. On the other hand, all the representatives of medium and small companies were ready to contribute/assist to the society. For instance, the engineers at “PUL” paid for physics and math tutorial classes for children from an orphanage, employed them for part-time jobs requiring no special skills (sometimes even if there was no special need for such vacancies) and tried to organize parties for them from time to time.

Half of the engineers in both IT companies and financial specialists in “Cascade Investments” combined work in the companies with teaching in the university, either in the Yerevan State University, or the State Engineering University. Some of them, again wishing to contribute to the society, conducted classes for developers (for salaries that hardly covered travel expenses) in the north-west regions that suffered most during the devastating earthquake in 1988 and where there is the highest unemployment up today. The bookstores and cafés chains, too, were involved in social activities, conducting special events for children. The owner of the bookstore contributed books to libraries of orphanages.

In an effort to perceive internal environment of the companies under study, I tried to find out how strongly an innovation in the form of theoretical research and/or practical input has been encouraged. In YBC, both theoretical research and practical input are encouraged, though no product innovation itself is expected or desired. “Star” encourages theoretical research to some extent and practical inputs are strongly encouraged. In bookstores and cafés, only practical input...
is welcome. Theoretical research is not encouraged in the studied small companies; they all are more focused on practical input and new ideas.

It is also worth to consider obstacles and stimuli to innovation in Armenia which the representatives of the organizations mentioned during the interviews. For instance, the most important obstacles for “Cascade Investments” are the underdeveloped financial sector, bureaucracy and ignorant investors. Besides, the respondent said that there is a lack of professionals, but a lot of smart students around. The secret is that education has always been an important family value for Armenians, but now education system fails to perform its functions. Other respondents mentioned unfair competition, underdeveloped or expensive information networks, closed borders (the engineers in “PUL” had difficulties with getting components from abroad), constraints to expand because of absence of online trading in Armenia, difficulties while dealing with other local companies due to bad management in those and the absence of marketing and fund raising skills (in IT companies).

As for the stimuli that companies find in the Armenian market, for instance, “Cascade Investments” thinks it is an advantage they can be pioneers in the new developing Armenian financial market. While other respondents find our legislation neither supporting, nor impeding their development, “Cascade Investments” looks forward to the new pension reform that starts in 2010 in Armenia which is a big step forward. Other good news for “Cascade Investments” (and for all us living in Armenia) is that NASDAQ OMX became the owner of the Armenian Stock Exchange (Armex) and the Central Depository of Armenia (CDA) and is going to introduce its technology and trade methods in Armenia which can become a breakthrough. As you can notice, nearly all the companies studied have partners abroad (or even mainly work with foreign partners in some cases) which is to a large extent due to Armenian Diaspora abroad that heavily invests in Armenia and tries to contribute to its development.

The description of Armenian business sector given above and the results of the study conducted within this thesis work have shown that the shortcomings at the micro-level are so numerous that a comprehensive reform of public and private sectors is required for the economic development of Armenia.

4.5 Summary

In Armenia, there are serious shortcomings in a number or areas, especially at the micro-level, which significantly lower its competitiveness in the global context and endanger the sustainability of economic development. These weaknesses are caused by general quality of the business environment, especially the financial sector, the lack of judicial independence, the prevalence of favoritism in government decisions, weak performance in higher education and training, low level of innovation. These shortcomings are so numerous that a comprehensive reform of public and private sectors is required, as well as improved operational and strategic performance of private sector.

Based on the theoretical framework, the analysis of secondary data and the qualitative analysis of the interview results, the following conclusions have been made regarding the overall picture of the current situation of NIS in Armenia:
1. Innovation policy conceptual and legislative measures are not supported by adequate targeted actions, programmes and financial commitments, and have a more declarative and fragmented character,
2. Low level of research infrastructure and under-financing of universities,
3. Extremely low public and private R&D expenditure,
4. Lack of incentives and public support measures for innovative and collaborative activities,
5. Absence of public procurement as a tool for innovation promotion,
6. Formal tax regulation is quite liberal, but in practice, burdensome in terms of both tax rates and administration and does not provide much incentive for investment in tangible and intangible assets,
7. The overall perception of the importance of clusters is to a greater extent lacking,
8. The link between S&T potential and other sectors of the economy and society have been disrupted,
9. Underdeveloped financial sector and extremely limited access to venture capital.

There are some steps directed at the consistent creation and development of NIS together with its basic elements and infrastructure, capable of ensuring sustainable development of the country and increasing its competitiveness as well as creating a favorable innovation environment for international economic co-operation. However, innovation policy conceptual and legislative measures have more declarative and fragmented character and are not supported by adequate financial commitments or tailor-made decisive actions consistent with general economic development trends.
The purpose of this thesis work was to identify specifics of the NIS model in two Nordic countries, namely in Sweden and Finland, investigate how the Nordic model of NIS has been implemented in Estonia, and define NIS development challenges in Armenia in order to draw conclusions on what lessons can be learned for the development of effective innovation policy in Armenia. Pursuing a more general goal, the general concept of NIS, key elements of NIS model and the NIS impact on economic performance were discussed.

In this work, an attempt was made to answer the following research questions supporting the purpose of this thesis:

1. What are the specifics of the NIS model in two Nordic countries studied, i.e. in Sweden and Finland (the main features and peculiarities of NIS in Sweden and Finland has been identified through a comparative analysis of the NIS in these countries with the NIS models in two non-Nordic countries, i.e. in Israel and South Korea)?
2. To what extent has the Nordic model of NIS been implemented in Estonia and what are NIS development challenges there?
3. What are NIS development challenges in Armenia?
4. What lessons can be learned for the development of effective innovation policy in Armenia?

As a result of a comparative analysis of NIS in Finland, Sweden, Israel, South Korea, Estonia, as well as an investigation of current situation of NIS in Armenia, the following conclusions were made:

1. What are the specifics of the NIS model in two Nordic countries studied, i.e. in Sweden and Finland (the main features and peculiarities of NIS in Sweden and Finland has been identified through a comparative analysis of the NIS in these countries with the NIS models in two non-Nordic countries, i.e. in Israel and South Korea)?

In two considered Nordic countries, Sweden and Finland, innovation policy is a pivotal element of the public policy. Both in Sweden and Finland, there are agencies responsible for coordination and implementation of national innovation policy, i.e. VINNOVA in Sweden, the National Technology Agency of Finland (Tekes). These two Nordic countries have a strong science base, a well-developed R&D infrastructure and a highly educated population. In Sweden and Finland, there are considerable R&D investments, though dominated by big international companies, as well as well-functioning regional and international networks and clusters.

The common challenges that these countries share are: support for R&D work in SMEs, integration of user perspectives into innovation projects, creation of tax incentives for risk-taking startups and individuals, availability of early stage venture capital, strengthening of research cooperation between academia, companies and public sector, internationalization of national science and technology institutions, and commercialization of research findings.

The success of the NIS models in Sweden and Finland is evident: recent studies have shown that Sweden is the most innovative country and has ranked among the innovative leaders in the EU. As for Finland, it has been the second in the OECD in terms of R&D intensity and the intensity of higher education R&D has doubled over the past 15 years. Since the mid-1990s, the country has systematically outperformed OECD and EU 15 average performance in labor productivity and GDP per capita growth rates. Because of the impressive results, the experience of Sweden and Finland in the NIS development has drawn attention of policy-makers and actors of NIS in other countries. Currently, there are international programs and projects through which
VINNOVA and Tekes share their experience with representatives from other countries and show how Sweden and Finland work with the development of innovation systems and commercialization of research.

2. To what extent has the Nordic model of NIS been implemented in Estonia and what are NIS development challenges there?

Estonia has undertaken some initial steps to implement the Nordic NIS model, but most of the key elements of innovation system are still underdeveloped. Foundation Enterprise Estonia (EAS), an agency similar to VINNOVA and Tekes, has been established to develop and implement innovation policy in Estonia, but it is difficult to measure the impact of its work in the short run. Currently, the EAS actively cooperates with VINNOVA and Tekes to learn and draw on their experience. To develop into the Nordic well-fare state, Estonia has to address such issues of primary importance as increase of public and private R&D spending, education system reforms, creation of knowledge-intensive export-oriented clusters in industry and service and many others.

3. What are NIS development challenges in Armenia?

R&D and innovation policies in Armenia emerged only in the mid 2000s; however they have more declarative and fragmented character and are not supported by adequate financial commitments or tailor-made decisive actions. R&D infrastructure is under-developed, and universities lack financing. Public and private R&D expenditures are extremely low, and there are no tax incentives and public support measures for innovative and collaborative activities. Armenia lacks developed clusters and networks, and what is worse there is no perception of their importance. There is no cooperation between technology and R&D institutions and other sectors of the economy and society, and academia-business-public sector cooperation is extremely weak. Financial market is under-developed, and companies and entrepreneurs have extremely limited access to venture capital.

4. What lessons can be learned for the development of effective innovation policy in Armenia?

To build a contemporary knowledge-based economy, it is important that Armenia moves towards the promotion and development of export oriented, high value-added sectors in the medium- to long-run. It is essential to develop research infrastructure, academia-business-public sector cooperation, increase education expenditures and R&D investments both in public and business sector, support R&D activities in SMEs. Cluster formation should be stimulated and necessary cluster infrastructure should be developed. Tax incentives for risk-taking startups and individuals and access to early stage venture capital should be created. Innovation policy changes should be accompanied by increase in actual funding and more public attention.

One of the main features of the Nordic model of NIS is that there is an agency responsible for coordination and implementation of national innovation policy, i.e. VINNOVA in Sweden, Tekes in Finland. Creation of such an agency in Armenia would eliminate fragmented character of innovation policy measures and coordination problems in their implementation. Such an agency covering similar areas of activity as VINNOVA and Tekes would be crucial in the establishment and development of the corresponding key elements of NIS in Armenia. The main areas of activity of this agency should include:

a) Support of companies engaged in risk-bearing product development projects,

b) R&D projects aiming at radical innovations in SMEs,

c) Strengthening of research cooperation between academia, companies and public sector,

d) Development and implementation of research and innovation strategies for specific sectors in cooperation with actors of NIS,
e) Building up of strong research and innovation environments through Excellence Centers, incubator programs, etc.,
f) Creation of universities’ own infrastructure for commercialization and focus on verification,
g) Regional development through the creation of regional innovation systems,
h) Funding of finance needs-driven R&D.

Taking into consideration the fact that Armenia extensively depends on external factors such as remittances and assistance from international donor and financial organizations, innovation policies need to be reinforced by macroeconomic policies that weaken current excessive external influence. A high level of coordination of the country’s policies and consistency in developing the framework of innovation system will be decisive in building a knowledge-based economy and improving Armenia’s competitiveness.
### Appendix A: Models of National Innovation System of Sweden, Finland, Israel, South Korea, Estonia and Armenia

#### Table 7: Model of National Innovation System of Sweden

<table>
<thead>
<tr>
<th>Human Capital</th>
<th>University</th>
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<tbody>
<tr>
<td>High quality education, 12.6 researchers per 1000 total employment, second only to Finland. Has one of the highest graduation rates in advanced research programmes (PhD or equivalent) among OECD countries; however, the number of science graduates per 100,000 employees is just below the OECD average and behind Finland and Australia (OECD, 2008, p. 154). Structural changes in higher education institutions aim at strengthening their quality, effectiveness and internationalization. The University Act will provide universities with more autonomy and financial power, and their management and decision-making systems will undergo reform by 2009 (OECD, 2008, p. 154).</td>
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</table>

| Work force mobility | Total mobility to and from institutes of higher education and industrial research institutes averages 23% over a 10-year period. Approx. half of the mobility can be traced to staff mobility within the sector itself, the other half of the mobility relates to moves to other sectors, mainly private sector. Thus, the level of mobility within sectors is very high (VINNOVA, 2006 (a)). |

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<tr>
<th>Infrastructure for performing R&amp;D</th>
<th>University</th>
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<tr>
<td>Higher education R&amp;D spending as a share of GDP is high (0.76%) and it performs around 20% of total R&amp;D, on a par with most OECD countries (OECD, 2008, p. 154). Swedish universities partly play the role that is played by industrial research institutes abroad (VINNOVA, 2006 (a)). The infrastructure for supporting commercialization of university research has been too fragmented and lacking in resources. The Innovation Bridge was established as a new strong player in 2005 providing seed financing (220 M€ in capital) and operating a National Incubator Program developed by VINNOVA (VINNOVA, 2006 (b)).</td>
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| Public and semipublic research institutes | Public research institutes play a minor role except in the area of defense. The largest are the Defense Research Agency and the National Testing and Research Institute (SP). So called industrial research institutes are funded jointly by industry and the government (ca 60% of their funding from industry, 30% from the government and the rest from the EU) (VINNOVA, 2006 (b)). The governance of the research institutes is fragmented, as IRECO, the Knowledge Foundation, and VINNOVA etc. all have such responsibilities (VINNOVA, 2006 (a)). |

| Techno parks, incubators | VINNOVA has developed a national programme for incubators. Since March 2005, VINNOVA has provided funds of SEK 50 million (~5,358,218 Euro) per year for an incubator programme that is run and developed together with Innovationsbron AB (VINNOVA, 2006 (a)). |

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<tr>
<th>Policy and regulatory framework</th>
<th>Innovation strategy and policy</th>
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Government provided 110 M € over five years in new funding for R&D-programs to be matched by industry (VINNOVA, 2006 (b)).

Swedish innovation policy is in a state of constant development. The Government has initiated a number of public inquiries in preparation for a 2008 bill on research in which support for innovation will be given importance. Among the issues currently under discussion are: granting universities more autonomy; allocation of funding based on quantitative and qualitative indicators; government support for basic research of strategic importance to industry; and support to innovative start-ups and small and medium-sized firms. In line with the general thrust for regulatory reform, the government is also placing more emphasis on the evaluation of the quality of research and innovation programmes and on assessing their socio-economic impacts (OECD, 2008).

Main features of Swedish Innovation System:
- High spending on R&D as percent of GDP
- Internationally oriented industrial firms and universities are dominating players
- Starting in 1988 a large part of the R&D-intensive major companies have merged with or been acquired by foreign firms
- Government funding of R&D has been concentrated to universities and the defense sector
- Public research institutes play a minor role except in the area of defense
- So called industrial research institutes are funded jointly by industry and the government (ca 60% from industry)
- University teachers have the right to their inventions unless other agreement has been made. Transfer of the rights to the respective universities is under consideration (VINNOVA, 2006 (b)).

### Innovation promotion and incentives
The regulatory system is to be changed so that the universities are given incentives to create institutions and regulations that support the commercialization of research results (VINNOVA, 2006 (a)).

VINNOVA conducts Forska&Vax (“Do Research and Grow!”) programme for stimulating radical innovation in SMEs. There were 33 funded R&D-projects of 316 applications during the first half year of program, 300 000 € per project with duration of 6-18 months. In 2006 and 2007, the budget was 11 M € per year, and VINNOVA seeks to increase the budget. The criteria for funding were: “shall strengthen the company’s capacity to compete on the global market and thereby contribute to the generation of economic growth and new jobs in Sweden”. Possible future introduction of tax incentives for R&D may compete with or complement the program (VINNOVA, 2006 (b)).

### Government procurement of technology products
Government support of R&D in companies traditionally very small in Sweden, except R&D related to military procurement or via European Space Agency (VINNOVA, 2006 (b)).

### Taxation
Starting from 2007, the government implements a tax-credit programme with a budget of SEK 200 million (~21,432,873 Euro) in order to support R&D work in SMEs. The programme is modelled on the SkatteFUNN programme in Norway under which companies, irrespective of their size, can apply for tax deductions for investments in R&D. Both the tax-credit programme and Forska&Vax (Research & Grow) programme aim to channel the demand of the companies (market pull) to research instead of the other way around (research and technology push) (VINNOVA, 2006 (a)).

### State institutions regulating and coordinating innovation
Ministry of Science and Education
- Special agency for coordination and implementation of national innovation policy VINNOVA:
  - Established in 2001
  - Budget 2006: 150 M € (excl. adm. expenses)
  - Staff: 176 of whom 49 PhDs
  - Leading government agency in the field of innovation under the Ministry of Industry, Employment and Communication
  - Mission: “Promote sustainable economic growth by financing needs-driven R&D and by developing innovation systems”
  - Focus: Strengthening research cooperation between academia, companies and politics/public sector in the Swedish innovation system.

Swedish Research Council and VINNOVA are two main pillars in the new system (VINNOVA, 2006 (b)).
| **Legal system, e.g. IPR protection** | University teachers have the right to their inventions unless other agreement has been made. Transfer of the rights to the respective universities is under consideration (VINNOVA, 2006 (b)).

Agreements that regulate IPR issues have been signed between some universities and the stakeholders from the private and public sectors. Together with the other parties, VINNOVA has initiated work aimed at drawing up a model agreement which incorporates IPR regulations into the main agreement in order to increase efficiency and thus reduce transaction costs. The work was completed in 2006 (VINNOVA, 2006 (a)). |
| --- | --- |
| **R&D funding** | **Private companies and Business Expenditure on R&D**

The business sector contributes the lion’s share: business expenditure on R&D accounted for 2.79% of GDP in 2006, compared to the OECD average of 1.56% (OECD, 2008).

The big international companies dominate the R&D-system. SME invest very little in R&D (VINNOVA, 2006 (b)). |
| **Public funding** | Government funding of R&D has been concentrated to universities and the defense sector (VINNOVA, 2006 (b)).

Universities dominate the public R&D-system (VINNOVA, 2006 (b)).

R&D conducted by the universities accounted for 21% of total R&D expenditures in 2006, which was the highest in the world. R&D conducted by Swedish research institutes and authorities is a low figure in international terms (VINNOVA, 2006 (a)). |
| **Angel & Venture Capital** | Limited, the supply of capital should be increased in regions that have a weak financial infrastructure. There are plans to achieve this by converting part of the funds of the European structural funds into risk capital (VINNOVA, 2006 (a)). |
| **Linkages and Networking** | The “Triple Helix” model is established through the VINN Growth program (regional innovation systems) based on experience from Telecom City. There are Triple Helix composed decision boards (VINNOVA, 2006 (b)).

Some of VINNOVA’s programs are aimed at supporting international cooperation. For instance, in 2005, VINNOVA worked in the biotech field with a focus on international collaboration (VINNOVA, 2006 (a)).

There are well-developed clusters and networks that vary in size - from the automotive industry throughout the country to clusters with a regional profile such as “Robot Valley” and “Telecom City” (VINNOVA, 2006 (a)). |
| **University-private business partnerships** | Very good industry-science relations, but dominated by larger firms. Manufacturing firms tend to be more innovative in process innovation than services, the Swedish services sector is much less innovative in this respect than services sectors in other OECD countries (OECD, 2008).

VINNOVA’s main areas of activity are strategic R&D programs in six major fields usually involving cooperation between universities and companies and other actors.

VINNOVA’s VINN Excellence Centers at universities – a new generation of strong environments for multi-disciplinary, problem-oriented research in close cooperation with business and industry and the public sector (VINNOVA, 2006 (a)). |
| **Research institute-private business partnerships** | VINNOVA’s Institute Excellence Centers are similar environments, like VINN Excellence Centers, but are located at research institutes and are sharply focused on the strong areas of Swedish industry.

Active Industrial Collaboration (AIS) is a project in which large and small companies work together with industrial research institutes and universities. The project aims, among other things, to promote joint learning and technology transfer but also to increase collaboration between industry and the academic sector. Approximately 450 companies, 300 of which are SMEs, are participating in 35 grant-supported projects in the fields of manufacturing, biotechnology, IT and sustainable development.

Research institutes are among organizations that have the task of helping SMEs to increase their know-how and expertise (VINNOVA, 2006 (a)). |
Table 8: Model of National Innovation System of Finland

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<th>Human Capital</th>
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<td>University</td>
<td>Educational system is on top in the WEF comparison. High educational level of population; women’s significant share of people with higher education degrees; plenty of R&amp;D personnel; many PhD degrees annually (STPC, 2008, pp. 11, 14).</td>
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<td>Work force mobility</td>
<td>Altogether 20.5 per cent of highly educated employees changed jobs in 2004 which was lower than in the previous years. Rates of mobility generally increase as the level of education rises, but an exception to this are persons with a licentiate level degree, among whom the rate of mobility was the lowest throughout the examined years (Statistics Finland, 2007). Not high, as it is difficult to move between sectors during a researcher career. Among other reasons are women’s slow progress in researcher careers, insufficient international mobility, small number of foreign researchers. The four-tier researcher career model is developed, based on the parallel development of financing instruments of the Academy of Finland, Tekes, and funds and foundations, and the task structure of universities and R&amp;D institutes, as a part of the Government programme in the field of Education, Research and Innovation (ERI) policy (STPC, 2008).</td>
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<tr>
<th>Infrastructure for performing R&amp;D</th>
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<tr>
<td>University</td>
<td>Finnish research and education system offers advantages over alternative locations. A relatively competitive location for industrial R&amp;D (Oinas, 2005, p. 1236). The intensity of higher education R&amp;D has doubled over the past 15 years (OECD, 2008).</td>
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</table>
| Public and semipublic research institutes | Well-functioning public research system. In terms of research volume, the largest institutes are:  
  - VTT Technical Research Centre of Finland (the Ministry of Employment and the Economy sector),  
  - Finnish Forest Research Institute (the Ministry of Agriculture and Forestry sector),  
  - Agrifood Research Finland (the Ministry of Agriculture and Forestry sector),  
  VTT Technical Research Centre of Finland is an impartial expert organisation. Its objective is to develop new technologies, create new innovations and value added thus increasing customer’s competitiveness. With its know how VTT produces research, development, testing and information services to public sector and companies as well as international organisations.  

Techno parks, incubators | Creation of 16 knowledge centers in regions with support of EU structural funds. The innovation structure will be complemented by Strategic Centers of Excellence in Science, Technology and Innovation in areas that are crucial for the economy (OECD, 2008). |

Policy and regulatory framework |                                                                                     |
| Innovation strategy and policy | Finland was the first country to adopt the concept of a NIS. The innovation policy is at the heart of the public policy. New Innovation strategy adopted in 2008 to strengthen its leading position. The strategy will orchestrate innovation policy across sectors, and will promote not only the so-called high-technology sectors but also innovative solutions and applications throughout the economy and society. Moreover, it will seek to improve cooperation and coordination between the regions and the national government. The innovation infrastructure will be complemented by Strategic Centers of Excellence in Science, Technology and Innovation in areas that are crucial for the economy. Moreover, structural changes in higher education institutions aim at strengthening their quality, effectiveness and internationalization. The University Act will provide universities with more autonomy and financial power, and their management and decision-making systems will undergo reform by 2009. Reforms to improve research careers, research infrastructures and sectoral research are already under way (OECD, 2008). Another core objective of the new strategy is to move beyond a primarily “knowledge push” environment, in which scientists and engineers come up with ideas and push them to the market, to a “demand pull” system, with private companies and users playing an active role in market-oriented innovation (Blau, 2008). |

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| Innovation promotion and incentives | The incentives allowed by the EU regulations and competition legislation for R&D and innovation are not fully utilized in Finland. A lack of clear incentives and inadequate opportunities for systems management have delayed the progress of reforms. Efficiency of incentives (incl. Public innovation subsidies and services, sufficiency of funding, development of the legislative framework, support for enterprises' internationalization and entry into markets) is now one of the key development areas of the expanding innovation policy (STPC, 2008). |
| Gover. procurement of tech. products | Public procurement is a seldom-used instrument (STPC, 2008). |
| Taxation | High taxation and rigid salary in international comparison (WEF, IMD, EU Innovation Scoreboard, OECD, Allianz) (STPC, 2008).

The new innovation strategy calls for creating tax incentives, especially for risk-taking startups and individuals. Under the plan, for example, up to €1 million ($1.4 million) for public money could be invested in a company viewed with significant growth potential through a new European young innovative company fund (Blau, 2008). |
| State institutions regulating and coordinating innovation | The key agents implementing science and technology policy are the Science and Technology Council (the coordinating body, bringing together high-level representatives from the government, industry, academia, and labour market organizations), the Academy of Finland, National Technology Agency of Finland (Tekes), The Finnish National Fund for Research and Development (Sitra), The Technical Research Centre of Finland (VTT), and the universities.

In Finland the formulation of national science, technology and innovation policies has been assigned to an expert body, the Science and Technology Council, which is chaired by the Prime Minister. The foremost organisations responsible for science and technology policies are the Ministry of Education and the Ministry of Trade and Industry. The Ministry of Education handles matters relating to education and training, science policy, universities and polytechnics, and the Academy of Finland. The Ministry of Trade and Industry is in charge of matters pertaining to industrial and technology policies, the Finnish Funding Agency for Technology and Innovation (Tekes), and the VTT Technical Research Centre of Finland. Nearly 80 per cent of the government R&D funding is channelled through these two ministries. The strategic aim for Finland is to secure sustainable and balanced social and economic development. Achieving this aim entails a high employment rate, high productivity and good international competitiveness. The role of the Science and Technology Policy Council is to contribute to the realisation of the strategy by means of science, technology and innovation policies and partly through education policy.

The innovation system approach has also been gaining importance within regional development. The network of Finnish universities and polytechnics, technology centres, the Centre of Expertise Programme, and other operations has developed innovation prerequisites in the regions to the extent that it is now possible to speak of the innovation systems of the regions and their development.  

Legal system, e.g. IPR protection | The general legal framework create an acceptable set of rules for innovative activities and utilization, but too often they still set out-of-date or otherwise inappropriate limitations. Numerous far-reaching development projects are under way in this direction (STPC, 2008). |
| R&D funding | Heavy R&D investment both by public and private sector (3.45% of GDP, second in OECD countries), or approximately €6 billion.

Business R&D stood at 2.44% of GDP in 2007.

Small percentage of business R&D funded from abroad (OECD, 2008).

Large Finnish Multinationals (Nokia) played crucial role both in terms of R&D performer and buyer of R&D conducted by universities and research institutions.

Nokia accounts for 45% of all industrial R&D in Finland, and more than 80% of the R&D investment in telecommunications sector (Blau, 2008). |
| Private companies and Business Expenditure on R&D | Very sector focused R&D: 50% of public R&D expenditure went to telecommunications

Around 28% of all R&D spending is paid by government (Blau, 2008). |
| Public funding | Non significant

Low foreign direct investments, limited venture capital for startups (Blau, 2008). |
| Angel & Venture Capital | Non significant

Low foreign direct investments, limited venture capital for startups (Blau, 2008). |

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Linkages and Networking

| Networking | Tight social networks and cross-sectoral linkages
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<tbody>
<tr>
<td>Networking</td>
<td>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&amp;D projects. Innovation centers are now located in the US, Japan, Russia, and China (Blau, 2008).</td>
</tr>
<tr>
<td>University-private business partnerships</td>
<td>Tekes technology programmes drive cooperation between firms, universities and research institutes, potentially including foreign partners. The Strategic centers for science; technology and innovation are established in sectors that are considered to best meet the long-term needs of Finnish industry and society. The objective is to promote the growth and renewal of the economy and create jobs. (forest, ITC, Metals and Engineering, energy and environment)</td>
</tr>
<tr>
<td>Research institute-private business partnerships</td>
<td>Cooperation between Finnish companies and research organizations is exceptionally widespread by international comparison (Oinas, 2005).</td>
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</table>

Table 9: Model of National Innovation System of Israel

<table>
<thead>
<tr>
<th>Human Capital</th>
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| University | Israel’s workforce is among the highest educated in the world – about 55% of Israel’s working population have 16+ years of education. 

8 universities and 27 other academic institutes, out of which 6 are world-class academic and scientific research campuses, each with its own specializations, history, and learning traditions. Of these 6 campuses, 4 are located within less than one hour’s drive from one another. The close proximity simplifies academic interplay and promotes crossover research, providing a good basis for Israel’s reputation as a center for multidisciplinary research. Additionally, upon graduation, many students are well acquainted with contemporaries and past advisors who are already employed in their fields. The natural result is that the transition from learning to working environments is more fluid, professional advancement is easier, and as professional careers progress, the proximity factor influences knowledge sharing, promotions, team building and even product design (Getz and Segal, 2008). 

The THES World University Rankings (The Times Higher Education Supplement, 2006) ranked three Israeli universities among the 200 world leading universities. |
| Work force mobility | From the last quarter of 1989 until 2001, more than a million immigrants from the former Soviet Union arrived in Israel. This immigration accounts for almost 20% of the country’s total population and about half of the technological workforce. There were 11000 talented and skilled scientists and research engineers with advanced training from top universities. Immigrants helped fuel Israel’s GDP growth from $11000 per capita in 1990 to $17000 per capita in 2000, while increasing the business sector product growth by 107%. The immigrants brought with them knowledge that Israeli entrepreneurs could embed in their technology-intensive ventures. 

The BASHAN program is a unique Israeli government organization for the encouragement and promotion of technological entrepreneurship, novel technologies, and innovative products, as well as the realization of technological and scientific potential of new immigrants in Israel. BASHAN offers its services free of charge to new immigrants from all over the world, returning residents, and potential (future) immigrants. |
| Infrastructure for performing R&D | 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 the IP, and forming optimal alliances among scientists, industry, and investors. Towards enabling the transfer of technologies to the business community, the OTTs play an active role in negotiating with strategic partners, licensees, and investors. |
Public and semipublic research institutes

Israel's ecological diversity, combined with its social and economical challenges, demands specific regional research. For this purpose, the Science and Technology Ministry, in collaboration with regional institutions, has established regional R&D centers throughout Israel. Currently there are 12 regional centers.

Regional R&D centers conduct feasible researches that promote Israeli research and solve regional problems at the same time. The centers serve as a link between the periphery and the center of Israel. In order to realize the full scientific, social and economical potential found in the periphery, regional R&D centers are based on leading researchers with a personal involvement and interest in the region, who are involved in all aspects of the center.

List of regional R&D centers in Israel:
- Migal - Galilee Technology Center
- The Golan Research Institute
- The Galilee Society
- Hameshulash - Kfar Kara
- The College of Judea and Samaria
- Yehuda Region
- The Dead Sea Research Center - D.S.R.C
- Ramon Science Center
- Hatzeva - Arava Region
- The Katif Research Center
- Houra - Bedouine Center
- R&D Centers in the Negev.

Techno parks, incubators

There are 24 (16 of which are privately owned) technological incubators in Israel today, out of which 15 are located in peripheral areas. One of the incubators was established as a biotech incubator. Approximately 200 projects in various stages of R&D are being hosted by the technological incubators at any given time. By the end of 2006, over 1000 projects had matured and left the incubators. Of these graduates, 57% have successfully attracted private investments; 41% (since the beginning of the program in 1991) are still up and running (Getz and Segal, 2008).

Policy and regulatory framework

The Law for the Promotion of Industrial Research and Development of 1984 is the principal mechanism for providing government assistance for high-tech industrial development. The purpose of the Law to enhance the development of local science-based industry by utilizing and expanding existing technological and academic infrastructure and by increasing the manufacture and export of high-tech products developed within Israel and thereby improve Israel’s balance of trade. Most recently, the Law was revised in 2005 in order to allow companies to request OCS permission and support for the transfer of know-how developed abroad (MOIT OCS Web site 2007).

Several new programmes for SMEs and traditional industries were established, as well as a EUR 21 million fund for nanotechnology and a EUR 25 million fund for biotechnology were created. A new programme for the development and commercialization of water technologies was introduced, and additional instruments for the water and renewable energy fields are being developed.

Israel’s innovation system is a key driver of economic growth and competitiveness. While the success of the Israeli system is primarily attributable to vibrant business sector innovation and a strong entrepreneurial culture, the government has also played an instrumental role in financing innovation, esp. in SMEs, and in providing well-functioning framework conditions for innovation, including venture capital, incubators, strong science-industry links, and quality university education (OECD, 2008).

Israel does not pursue an explicit innovation policy, nor are there specific measures for encouraging innovation as a tool for achieving objectives. Innovation is encouraged as a by-product of R&D-encouragement programs. In these programs, innovation is a paramount criterion, but the objective is to encourage R&D that will lead to manufacture, employment, and export (Getz and Segal, 2008).

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Innovation promotion and incentives

Most government ministries have a chief scientist to encourage the commercialization of science and technology in their respective area of responsibility.

A government seed fund – the Heznek Fund – was launched in 2002 to share investors’ risk in new start-up companies. The program emits a positive signal to investors and creates further incentives for mobilizing investments for the establishment of start-up companies. The program is based on the government matching any investment made in a start-up company and on giving the investor a two year option to purchase the government’s shares in the start-up company at the initial price.

There are also National Programs aimed at:
- Support of Generic R&D, e.g. MAGNET with its four tracks: Consortia (generic technology R&D), Magneton (technology transfer), Nofar (basic and applied research) and Association (distribution and implementation).
- Pre-Seed Programs, like technological incubators, Tnufa (a promotion program designed to give momentum to promising and determined entrepreneurs in developing start-up companies), Nofar (Getz and Segal, 2008).

Government procurement of technology products

The Israel Defense Forces (IDF) is often credited for playing a major role in the continuous success of the Israeli high-tech industry. Military service is compulsory in Israel, therefore, the IDF is the first employer of the majority of secondary school graduates. The IDF typically entrusts its soldiers with highly responsible jobs, young soldiers manage projects with sizable budget and carry out work for which quality, responsibility, and resilience under stress are paramount.

The IDF’s Center of Computing and Information Systems (MAMRAM) and School for Computer Professions have a prominent influence on the Israeli software innovation system.

The army regularly invests large amounts of money in research and development. Israel has always strived to maintain a strong military advantage.

In the mid-1980s, when the project of development of Lavi jet fighter was abandoned, the defense industries shifted their focus to advanced systems designed to be installed in acquired American or other platforms. Development of these auxiliary systems provided local high-tech industries with an advantage in producing civilian spin-offs in areas of security, electronics, software, and internet.

Taxation

A wide range of taxation and customs treaties.

The Israeli income tax authorities consider expenditures on R&D projects approved by the Chief Scientist as direct deductible expenses rather than as investments. Tax incentives are offered to: (1) any investor in an R&D program who is not a shareholder in the company, (2) any enterprise owner who is doing research for the enterprise’s development, and (3) any scientific employee/worker who works during a sabbatical year, whereby incentives are given proportionately to salary.

In 2002, the Knesset approved the tax reform recommendations of a government committee the main of which were:
- imposition of a tax on individuals’ capital income,
- gradual reduction of taxes on labor income,
- narrowing of the differentials between tax on capital income in Israel and abroad
- reduction of the difference between taxation on capital and on labor in Israel.

Strict limitation on technology transfer and overseas production was imposed upon recipients of government research and development incentives. Only in 2005, an amendment was legislated to allow companies to request OCS permission for the transfer of know-how developed with the support of the OCS abroad. Given the widespread use of such incentives, many foreign investors in Israeli technology firms found it difficult to relocate manufacturing operations and proprietary technology outside Israel. Procedures have been put in place to deal with multiple scenarios, royalties are now to be paid to the OCS and repayments are channeled back to the OCS budget and used to support other projects.

An OECD review of tax incentives concludes that the effectiveness of fiscal incentives for R&D depends very much on the design of tax measures relative to policy objectives (OECD, 2004). In principle, fiscal incentives should target R&D activities, and not support specific enterprise sectors or groups.
The main government bodies in charge of Israel’s innovation policy are:
- Ministry of Industry, Trade and Labor (MOIT),
- Ministry of Science and Technology (MOST),
- Ministry of Defense,
- Ministry of National Infrastructures,
- Ministry of Agriculture and Rural Development,
- Ministry of Immigrant Absorption,
- National Council for Civil Research and Development (MOLMOP) headed by the MOST,
- Council of Higher Education headed by the Minister of Education.

The role of the Office of the Chief Scientist (OCS) at the MOIT (with a budget of EUR 223 million in 2006 and EUR 219 million in 2007 – OECD, 2008) is to assist in the development of the new technologies in Israel, as a means of fostering the Israeli economy, encouraging technological entrepreneurship, leveraging Israeli science-skilled resources, supporting high added value R&D, enhancing the knowledge base of Israeli high-tech industries, and promoting cooperation in R&D, both nationally and internationally (Getz and Segal, 2008). The OCS has funded one out of five project proposals in recent years.

All of Israel’s major universities are publicly owned and funded. The attitudes and methods that exist today are profoundly influenced by this basic bond to the Israeli government. Universities recognize the conflict of interest that is likely to emerge owing to the collaboration between researchers from academia and those from industry and other commercial enterprises, nevertheless, all universities encourage such collaboration and most of them cherish the academic freedom of faculty members, above any other economic benefit that may ensue.

In Israeli universities, inventions derived from public funding are registered as university-owned patents. All of the universities practice a formula whereby royalties received from commercialized patents and new discoveries are distributed proportionally between the institution and the inventor.

First in the world in civilian R&D spending as a proportion of GDP, with an overall investment of 4.6%, compared with the OECD average of 2.26%. As a result, Israel’s workforce includes 138 R&D professionals per 10000 employees – about three times the ratio in the UK.

Innovation is extensively financed by the government, both directly and indirectly. Direct financing is administered mainly through the implementation of the Law for Encouragement of Industrial Research and Development, the technological incubators program, and the MAGNET program. Funding rates vary between 30% and 85% of approved budgets for salaries, materials, and subcontractors, and are subject to limitations and ceilings according to the specific programs and to repayment of royalties. Changes in financing rates are contemplated in order to achieve more flexibility in grant allocation. R&D projects supported by the OCS within the framework of the above-mentioned law are entitled to funding of their patenting expenses.

Indirect financing by government is administered by giving tax concessions to organizations and companies that actively support innovation-oriented activities. Such organizations include:
- MATIMOP, the Israeli industry R&D center;
- Inbal, a government fund established to support research and development funds by purchasing 80% of the shares from any investor wishing to sell;
- The Investment Promotion Center, which runs a variety of programs aiming to encourage industries and businesses to achieve the goals of growth, sales, export increase, profitability increase, and additional employment;
- the Yozma fund that focuses on attracting foreign capital for investment in the Israeli high-tech industry.

Thus, huge efforts have been invested in direct support of mostly small firms and small industries in their research. This has generated and an enormous amount of research by small companies, leading to new ideas – many of which became the basis for start-ups and companies.

And in the early 1990s, the government initiated several programs to support and offer entrepreneurs an opportunity to develop their innovative technological ideas and set up new businesses in order to commercialize them. Two examples of these programs are the technological incubators and Yozma – an outstandingly successful program that was designed to create a local VC industry from a very limited starting base. At present there are over 100 active funds collectively managing over $12 billion in VC market in Israel (Getz and Segal, 2008).
The venture capital (VC) industry is highly developed. Israel hosts over 100 active funds, collectively managing over $12 billion. The year 2006 was a year of impressive fund gains, as well as numerous successful exits for VC firms doing business in Israel. The most recent growth trend began in mid-2003 and covers a broad range of Israeli high-tech industries. The first half of 2006 showed a capital investment of $764 million, up to 4% over the same period in 2005. Israel also remains an attractive target for commercial investment by foreign companies. In the first half of 2006, more than 50 Israeli firms were the subject of mergers and acquisitions, with investments of over $12 billion. Foreign investments and M&A activities are expected to expand in 2008, when Israel formally adopts the International Financing Reporting Standards (Getz and Segal, 2008).

Very strong links with capital markets, mainly in the US, developed over 30 years; multiple types of agreements with the EU, including for trade and R&D; strong relationships with key Asian countries. A number of destinations have been selected for diplomatic science relations with Israel: the former Soviet Union, the countries of the Pacific Belt (Southeast Asia, with special emphasis on Singapore and Japan), and the countries of Central and Eastern Europe.

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 different research institutions in order to promote international cooperation in common research areas.

Israel is a member in several international organizations and an affiliated member in many more organization (such as the EU the 6th Framework Program, OECD, UNESCO, and ESRF) (Getz and Segal, 2008).

In 1995, the MOST initiated the establishment of the Scientific and Technological Infrastructure Development Program. It is aimed at harnessing the professional manpower and economic potential that can be derived from Israeli science. The program mediates between the academic basic research and the applicative development. In addition, it provides for the training and nurturing of the elite professional workforces required for the chosen prioritized fields. The program was implemented by six national Committees for Technological and Scientific Infrastructure Development, covering six fields in which Israel holds a world-class position: electro-optics, biotechnology, advanced materials, information and teleprocessing, micro-electronics, and water and environment research. Graduates of the program eventually become the leading force in the Israeli high-tech industry (Getz and Segal, 2008).

The Global Enterprise R&D Cooperation Framework was established by the OCS in order to encourage industrial R&D cooperation between Israeli and multinational companies (MNCs). The Global Enterprise R&D Cooperation Framework provides a range of significant incentives, through which the OCS shares the high risks and costs inherent in high-tech development with the partnering companies. Each cooperation model is tailored to the MNC’s specific needs and requirements.

The Israeli Industry Center for R&D (MATIMOP) is a public non-profit organization founded by the three major associations of manufactures in Israel. MATIMOP functions as the interface between Israeli companies and their international counterparts to promote joint development of advanced technologies. It encourages participation in industrial R&D. The international R&D activities include participation in the European RTD framework program, EUREKA, and binational R&D-oriented agreements coordinated on behalf of the OCS by MATIMOO. The center also manages a group of binational R&D funds and runs an encouragement program aimed at creating R&D cooperation between Israeli research entities and multinational companies (Getz and Segal, 2008).
Table 10: Model of National Innovation System of South Korea

<table>
<thead>
<tr>
<th>Human Capital</th>
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<tr>
<td>University</td>
<td>With the implementation the government’s universal primary education policy, followed by the secondary school equalization policy accompanied by the successful economic growth, the Korean education system now provides higher education opportunities for about 70% of high school graduates. During the past several decades, the Korean higher education sector has experienced tremendous expansion, while the quality of teaching and research has not improved very much (Kim and Lee, 2004). Korea is building a solid foundation to systematically nurture and utilize S&amp;T human resources. Korea enacted “A Special Law to Support Science and Engineering” in 2004 and pursuant to this law, introduced the “1st Basic Plan to Nurture and Support Science and Engineering Human Resources (2006-2010)” in 2005. Furthermore, as a measure to develop women scientists, the policy for increasing the employment rate of women scientists has been broadened and support centers for women scientists and engineers are being established and in operation (MoST, 2007).</td>
</tr>
<tr>
<td>Work force mobility</td>
<td>It is considered that the Korean war, despite destroying large parts of the industrial infrastructure actually helped the subsequent economic development by completely transforming a traditional rigid society into a highly mobile one by forcing geographical mobility (Kim 1993). The Brain Pool program is geared to attract foreign scientists and researchers to enhance scientific and technological exchanges. Since 1994, this program has contributed to forging the global networking with more than $35 million invested to invite 1,220 foreign scientists and researchers. The regular invitation program for overseas prominent Korean scientists so-called the “Ultra Program” was launched to encourage domestic scientists to forge a close network with scientists abroad. The government runs the “Global Laboratory Program” to acquire up-to-date knowledge on cutting-edge fundamental technologies by tapping the talent of Science and Technology (S&amp;T) experts abroad by creating a global network with regard to core fundamental technologies (MoST, 2007).</td>
</tr>
<tr>
<td>Infrastructure for performing R&amp;D</td>
<td>Universities tend to play a minor role in R&amp;D, as they have historically been teaching institutions. Continued support for the development of capabilities and research infrastructure in universities and more strenuous efforts to diffuse knowledge from the public to the private sector is one of the key challenges for Korea (OECD, 2008). Korea can improve the innovation system by upgrading the quality of universities through deregulation and competition and increasing their relatively limited role in R&amp;D (OECD, 2009).</td>
</tr>
<tr>
<td>Public and semipublic research institutes</td>
<td>Korea is vigorously enhancing the innovative research capability of government-sponsored research institutes (GRIs) and has launched the “Top Brand Project”, which is aimed toward specifically promoting the research capacity of each GRI in their S&amp;T fields of comparative advantage. The government has also introduced particular measures to enhance collaborative research between GRIs to develop infrastructural and generic technology, in addition to cutting-edge technologies and fusion technology (FT). Korea is at the forefront of nurturing S&amp;T-based service industries with systematic framework set up to develop and support R&amp;D service industries, and programs such as the “1st Basic Plan for the Development of Professional Engineers (“07~’09)” form a comprehensive support system to boost the competitiveness of Korea’s engineering services (MoST, 2007).</td>
</tr>
<tr>
<td>Techno parks, incubators</td>
<td>The “3rd Comprehensive Plan for the Promotion of Regional S&amp;T (2008-2012)” will be launched to revitalize the regional economy through innovation in regional science and technology. Furthermore, two additional scientific research complexes have been selected to be developed into hubs of regional innovation in Busan and Daegu, bringing the total number of complexes to 7. The Korean government plans to develop up to ten regional complexes by 2010 and to support each complex with up to US$ 15 million for a maximum of five years. Regional Science R&amp;D Complexes: - 2004: Daejeon, Jeonbuk Province, Gwangju - 2005: Chunghubuk (Ochang) - 2006: Gangneung - 2007: Busan, Daegu The Daejeon (Daedeok) complex was nurtured as a Science Town by the government starting in the 1970s. This led to the establishment of an excellent R&amp;D infrastructure, including research institutes, universities and industries, and the complex was designated as the Daedeok R&amp;D Special Zone in 2005 pursuant to the “Special Law for Daedeok”. The government has been fostering the Daedeok R&amp;D Special Zone with a view to creating a world-class innovation cluster through the cultivation of venture businesses and active commercialization of research results. The Special Zone is expected to nurture 1,500 high-technology start-ups and to generate an annual revenue of 9.7 billion dollars by 2010 (in 2004, there were 824 high-tech enterprises) (MoST, 2007).</td>
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</table>
Innovation and creativity have been a policy focus for some time. Various ministries are involved in science, technology and innovation policy, and recent initiatives have attempted to bring greater coherence to the system. For example, the R&D Total Roadmap seeks to set the public research base on a strategic path. Korea is also attempting to broaden the spectrum for future growth by funding biotechnology, nanotechnology and other promising areas (OECD, 2008).

Korea consolidates its future growth potentials by implementing the Future Growth Engine R&D Program and by developing technologies through current R&D programs such as the “21st Century Frontier R&D Program”. In the Future Growth Engine R&D Program, the government provides indirect support to private R&D activities by making early-stage investments in basic and fundamental technology, reforming the R&D incentive system and supporting human resources development. Launched in 1999, the “21st Century Frontier R&D Program” aims toward augmenting national competitiveness in strategic technologies of the future and enhancing public welfare and quality of life. The government plans to invest up to US$100 million for a period of 10 years in each of the Program’s 22 projects (i.e. programs that will have positive economic impact, improve quality of life and meet public needs) (MoST, 2007).

If government R&D investments are made in accordance with the suggested technologies contained in the Total Road Map, R&D investments for technologies such as biotechnology, energy technology, environmental technology and basic sciences will increase, whereas investments for technologies such as machinery, manufacturing process, information and electronics technologies will decrease (MoST, 2007).

Innovation promotion and incentives
The Korean government is committed to establishing a stable research environment for scientists and engineers as well as strengthening its support in a number of important areas. The government has been undertaking a mutual benefit pension program since 2004 to secure the post-retirement welfare benefits of scientists and engineers and has taken measures to expand the incentives offered to researchers participating in R&D projects from 35% to 50%. Furthermore, the “Techno Doctor Project”, which enlists retired scientists and engineers to address the shortage of skilled S&T experts at small and medium sized enterprises, was established in 2006, and the tenured researcher system has been introduced. In addition, the “Research Fund Management Certification System”, which promotes the transparency of R&D fund management by providing incentives to research institutes with outstanding R&D fund management systems, and the “Student Wage Pooling System”, which pools student wages to be managed by specific research institutions, are being conducted as pilot projects (MoST, 2007).

Government procurement of technology products
Korea is actively supporting research on fusion energy. The government is pursuing joint development of the ITER (International Thermonuclear Experimental Reactor) project (2007-2015, 861.5 billion won (estimated) ~ 488,770,783 Euro) with other advanced countries and will be completing the KSTAR (Korea Superconducting Tokamak Advanced Research) project in August 2007. Korea is participating in the international planning and development of the Generation-IV Nuclear Energy Systems (Gen-IV), and the domestic front, the Optimized Power Reactor 1000 (formerly known as the Korean Standard Nuclear Plant) and the Advanced Power Reactor 1400 (originally named the Korea Next Generation Reactor) are in operation and under construction, respectively. Furthermore, new high-end industries are being created based on radiation fusion and medicine technology.

Korea has enacted the “National Space Development Promotion Act”, which is aimed towards the advancement of space development and in furtherance of this aim, has issued the “Basic Plan for Mid- and Long-term Space Development (1996-2015)” and formed the National Space Council to support and coordinate R&D investments and space development activities effectively. The government is also fostering professional research institutions for space development.

Korea is building a rocket capable of launching a small satellite weighing 100 kg into orbit and was planning to complete construction of its own space center and to launch a Korean-built satellite with a domestically-developed satellite launch vehicle in 2008 (MoST, 2007).
## Taxation

In the line with the efforts to increase the S&T innovation capacity of companies, the Korean government offers companies several tax benefits such as income tax reduction and corporate tax cuts, and the following technical support system is up and running to assist research institutes and R&D departments of companies.

1. **Tax credit for research and manpower development costs.**
   Ex post facto credit against corporate tax or income tax on the research and manpower development costs for each taxable year at a prescribed rate (Article 10 of the Tax Exemption Limitation Act).

2. **Tax credit for equipment investment related to research and manpower development.** Credit against tax on equipment investment related to research and manpower development or new technology commercialization at a prescribed rate (Article 11 of the Tax Exemption Limitation Act).

3. **Local tax breaks related to real estate for enterprise-annex research institute.** Local taxes (acquisition/registration/property taxes) related to real estate waived for enterprise-annex research institute (Article 282 of the Local Tax Act).

4. **Income tax credit for the R&D activity costs for SME researchers.** Credit against taxable income of a specific amount if personnel in charge of research at an SME-annex research institute receive funds for research activity expenses as per the wage regulations (Article 38 of the Enforcement Decree of the Income Tax Act).

5. **Customs exemption/reduction for goods for industrial technology R&D.** Reduction and exemption for 80% of the customs imposed on machines/tools/materials for R&D as separately announced among advanced machines/tools/materials imported and reagents/parts/goods/raw materials/samples for R&D (Article 90 of the Customs Act).

6. **Technical researcher system.** National military duty exempted for a quota of technical researchers newly hired by company-affiliated research institutes. As a result, the number of company-affiliated research institutes has increased from 7,110 in 2000 to 13,680 in 2007 (MoST, 2007).

### State institutions regulating and coordinating innovation

**Ministry of Science and Technology** which serves as secretariat of National Science and Technology Council chaired by President of the country.

In 2004, the administrative system for S&T was restructures fundamentally. The Ministry of Science and Technology was elevated to a Deputy Prime Ministry for the effective planning, coordination, and evaluation of S&T innovation-related policies. In addition, the Office of Science and Technology Innovation (OSTI) was created to take responsibility for the allocation of the national R&D budget and for the coordination of S&T human resources policies and regional technology innovation policies (MoST, 2007).

### Legal system, e.g. IPR protection

N/A

### R&D funding

**Private companies and Business Expenditure on R&D**

Korea has very large firms and a strong focus on information and communication technologies and automobiles. R&D expenditure has grown rapidly in recent years and Korea is now among the OECD leaders in terms of R&D intensity, i.e. gross domestic R&D expenditure was over 3.2% of GDP in 2006. Business enterprises account for most of the R&D expenditure, financing 75% and performing 77% in 2006. The emphasis is on development rather than on basic research. Service sector accounts for a small share of business R&D and for little in-house product or process innovation. With services now accounting for more than 50% of GDP, improving innovation in services is crucial (OECD, 2008).

**Public funding**

The government has increased its spending on R&D and set targets designed to increase basic research (OECD, 2008).

Government aid for innovative individual research out of basic research is being increased from 35.7% in 2006 to up to 60% in 2011, and from 2007 onwards, the government plans to devote at least 25% of its research budget towards basic research (MoST, 2007).

**Angel & Venture Capital**

During the 1980s, the Korean Government created the venture capital industry by forming the first Venture Capital company in a special partnership between the state and private firms. The subsequent Small and Medium Enterprises Formation Act in 1986 lead to another 12 Venture Capital firms being formed, funded by a combination of state and private sector (Kim, 1993). In addition, the New Technology Commercialization Financing Promotion Act set up in 1986 promoted the formation of financial institutions that only financed the high technology sector. Thus, entrepreneurs in Korea have a steady supply of capital (Kim and Dahlman, 1991).
### Networking
Korea is contributing to global S&T development by actively participating in multilateral R&D programs, such as ITER (International Thermonuclear Experimental Reactor), the EU Framework Programme, and CERN (European Organization for Nuclear Research).

Korea has built a strong S&T cooperation base by concluding S&T Cooperation Agreements with 46 nations from around the world, and by organizing Joint S&T Committee Meetings, S&T forums and seminars. Furthermore, the government assigns Korea S&T volunteers to developing countries under the “Techno Peace Corps Program”, which has been designed to support S&T development through the transfer of S&T development models and experience (MoST, 2007).

The government has been increasing its support of the “Global Research Laboratory (GRL)” Program every year which promotes international joint research with nobel laureates and preeminent scholars abroad. Continuous support of programs such as the “Global Partnership Program (GPP)” encourages outstanding foreign R&D centers to establish joint research centers in Korea and to conduct mutually beneficial research projects with Korean scientists. E.g.

- Hanyang University cooperates with RIKEN research center in Japan,
- Seoul National University with electronic International Molecular Biology Laboratory (eIMBL), etc. (MoST, 2007)

### University-private business partnerships
Universities tend to play a minor role in R&D, as they have historically been teaching institutions (MoST, 2007). Collaboration is very weak. Universities attract very little funding from the private sector. Instead, more common are informal collaborations through the usage of consultancy from individual members (Kim 1993).

### Research institute-private business partnerships
There is little collaboration between SMEs and the public sector and relatively few international linkages (e.g. very little cross-border involvement in patenting). As a result, the R&D landscape is dominated by the indigenous private sector.

The number of triadic patent families has grown immensely in the last decade and is now well above the OECD average when adjusted for population (MoST, 2007).

Between industry and public research institutes, collaborations are more frequent as the government provides subsidies and financial incentives.
Table 11: Model of National Innovation System of Estonia

<table>
<thead>
<tr>
<th>Human Capital</th>
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<tbody>
<tr>
<td><strong>University</strong></td>
<td>Low education expenses per capita: in 2005, the figure was 517USD in Estonia, compared to 3213USD in EU5. Lack of qualified engineers, relatively insufficient availability of information technology skills, comparatively low share of people with higher education as compared to the five most successful countries in this category (Sweden, Belgium, Ireland, Finland, and France) (Estonian Development Fund, 2008).</td>
</tr>
<tr>
<td><strong>Work force mobility</strong></td>
<td>Estonian higher education and research funding level is insufficient to support a functioning system of researcher mobility (Archimedes Foundation, 2007). Many post-graduate students and senior staff work part-time for private sector companies, due to the large difference between the salaries of the universities and enterprises.</td>
</tr>
<tr>
<td><strong>Infrastructure for performing R&amp;D</strong></td>
<td></td>
</tr>
<tr>
<td><strong>University</strong></td>
<td>During the period from 1996 to 2004, R&amp;D expenditures have growth continuously in higher education sector, by 15% a year on the average. In 2004, R&amp;D expenditures in higher education sector were 45.5% of total R&amp;D expenditures (Estonian Ministry of Education and Research, 2007). Low level of research infrastructure, under-financing of universities, lack of necessary research equipment</td>
</tr>
<tr>
<td><strong>Public and semipublic research institutes</strong></td>
<td>Low level of research infrastructure</td>
</tr>
<tr>
<td><strong>Techno parks, incubators</strong></td>
<td>Science and technology parks and incubators will be developed, and the main focus will be on expanding the range of services and support instruments offered to enterprises, raising the qualification of employees and developing the infrastructure. Cooperation with international companies and their involvement in science and technology parks will be encouraged (Estonian Ministry of Education and Research, 2007).</td>
</tr>
<tr>
<td><strong>Policy and regulatory framework</strong></td>
<td></td>
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<tr>
<td><strong>Innovation strategy and policy</strong></td>
<td>Estonian RD&amp;I Strategy 2007-2013 “Knowledge-based Estonia” focuses on sustainable development of the society by means of research and development, and innovation. It contributes to the achievement of the goals of Estonia’s long-term development strategy “Sustainable Estonia 21” as well as the Lisbon Strategy (the strategy for growth and jobs). The current strategy is the follow-up of Estonian Research and Development Strategy 2002-2006 “Knowledge-based Estonia”. The RD&amp;I strategy addresses the following challenges that Estonia is facing, i.e. challenges:</td>
</tr>
<tr>
<td></td>
<td>• to the organization of RD&amp;I;</td>
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<td></td>
<td>• to entrepreneurship and economic competitiveness;</td>
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<td></td>
<td>• to the public sector and development of RD&amp;I policy.</td>
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<td></td>
<td>The strategy sets out three main objectives:</td>
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<td>• competitive quality and increased intensity of research and development;</td>
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<td></td>
<td>• innovative enterprises creating new value in the global economy;</td>
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<td></td>
<td>• innovation friendly society aimed at a long-term development.</td>
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<tr>
<td></td>
<td>The strategic key technologies in supporting research and development, and innovation are:</td>
</tr>
<tr>
<td></td>
<td>• information and communication technologies;</td>
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<td></td>
<td>• biotechnologies;</td>
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<td>• material technologies.</td>
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<td>The objectives set in the strategy will be achieved through four measure:</td>
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<td>• development of human capital;</td>
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<td></td>
<td>• organizing the public sector RD&amp;I more efficiently;</td>
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<td></td>
<td>• increasing enterprises’ innovation capacity;</td>
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<td></td>
<td>• policy-making aimed at long-term development of Estonia.</td>
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<tr>
<td></td>
<td>The total expenditure on research and development is planned to be increased to 1.5% of GDP by 2008 and to 3% of GDP by 2014, of which the business sector research and development investments cover more than a half (1.6% of GDP). The proportion of employees involved in research and development has to increase to 8 researchers and engineers per 1000 employees and the productivity of enterprises per employee has to reach 80% of the average of the European Union 25 member states (Estonian Ministry of Education and Research, 2007).</td>
</tr>
</tbody>
</table>
### Innovation promotion and incentives

Estonian Science Foundation implements from 2008-2015 Researcher Mobility Programme MOBILITAS to activate international exchange of scientists and knowledge. The total budget is 317.64 million kroons (~26,857,933 US Dollar), of which up to 85% is granted by the European Social Fund, state funding is no less that 10% and self financing of the partner (Estonian research and development institution) reaches at least 5%.  

#### Government procurement of technology products

Demand for new technologies will be stimulated (e.g. transport, energy, environment, health care, education, communications). Functional requirements will be defined in public procurements so that business enterprises will have a numerous variety of choices for offering innovative solutions. Best practices valuing research, innovation and professional design will be disseminated among the organizers of public procurements (Estonian Ministry of Education and Research, 2007).

#### Taxation

The impact of tax incentives and the practices of other countries in developing research and innovation will be analyzed (Estonian Ministry of Education and Research, 2007).

#### State institutions regulating and coordinating innovation

Estonian RD&I Strategy 2007-2013 “Knowledge-based Estonia” (incl. the national programmes covering different fields) will be implemented under the leadership of the Ministry of Education and Research (MER) and the Ministry of Economic Affairs and Communications (MEAC) in cooperation with other ministries, which are responsible for initiating and implementing national R&D programmes in their areas of administration. The Government of the Republic, advised by the Research and Development Council (RDC), organizes the overall implementation of the strategy (Estonian Ministry of Education and Research, 2007).

#### Legal system, e.g. IPR protection

The strategic activities of “Estonian Enterprise Policy 2007-2013” include the development of legal environment. Measures for increasing the intellectual property protection activity will be generated and implemented, incl. increasing the awareness and knowledge of the society about intellectual property as well as the protection of intellectual property will be valued while defining the terms of reference of national R&D support programmes (Estonian Ministry of Education and Research, 2007).

The real knowledge concerning protection of intellectual property is very low in Estonian enterprises (Luik, 2004).

### R&D funding

#### Private companies and Business Expenditure on R&D

Total expenditure on research and development in Estonia has increased from 0.71% of GDP in 2001 to 0.88% of GDP in 2004 (the average of the 25 member states of the EU was 1.9% of GDP in 2004). The EU has set a goal to increase the total expenditures on R&D to 3% of GDP by 2010.

As a positive trend, private sector R&D investments have grown faster than public sector R&D investments. While in 1999 the private sector investments made up only 23.9% of the total R&D investments, in 2004 the corresponding indicator was already 39%. The rapid growth was caused by the low level of private sector R&D investments in 1999, but also by enterprises' closer cooperation with research and development institutions, as well as state support to enterprises' research and development projects.

Nevertheless, the share of the private sector in research and development is still considerably lower than in developed countries (63.1% in the USA, 69.5% in Finland, the EU average is 55.5%) (Estonian Ministry of Education and Research, 2007).

The results of the Community Innovation Survey show that 29% of the studied enterprises made expenses on innovation. In most cases, the expenditures were associated with the acquisition of machinery and equipment as well as the accompanying training. Out of the total turnover of innovative enterprises, total expenses on innovation amount approximately to 2.3% in manufacturing and only to 0.8% in services (Luik, 2004).

#### Public funding

Public expenditures on R&D were 0.39% of GDP in 2004, it is planned to increase public expenditures up to 1.4% in 2014 (Estonian Ministry of Education and Research, 2007).

In 2005, the R&D expenditures per capita were 95 USD in Estonia, whereas in EU5 – 1231 USD. In 2006, 0.3% of enterprises received aid for innovation from the public sector, in the EU 5 most active countries the relevant figure was 23.3% (Estonian Development Fund, 2008).

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Angel & Venture Capital

The development of the venture capital market in Estonia has received much attention over the last two years due to plans to initiate a government supported venture capital fund. The Estonian venture capital market is still small and therefore there are very few venture capital funds. Venture capitalists require quite a high rate of return (16-35%) because of the very high risks.

The Development Fund introduced venture capital financing in September 2007. By autumn 2007 the Investment Division was staffed, analysis procedures and contract forms were prepared and the investment committee was assembled.

One of the tasks during its first year of operation was to get a clearer picture of Estonia's venture capital market and its shortcomings in order to specify the fund's operating focus and methods for the following years.

The first direct corporate investments were planned for 2008 and the selected companies were SmartPost and Ilmarine Engineering. Fund investments were not planned for the first year, neither are any investments currently made into seed-stage companies. Meanwhile, workshops are held to introduce the work done by the fund and bring together market players. 8

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Linkages and Networking

Networking

Low level of development of enterprise networks and clusters (Estonian Development Fund, 2008).

University-private business partnerships

At present, the interplay between the technology and science subsystems and the knowledge transfer are considerably underestimated. To develop the transfer of high-level technology, the technology competence centers have been established at Tallinn University of Technology (TTU) and University of Tartu. The main areas for these centers are: material engineering, information technology, environmental technology, and bio- and genetic technologies.

The Testing Center has been established at beginning of the 1990s at TTU. The main objective of the Testing Center is the effective use of university laboratories and testing facilities. One of the laboratories has been accredited internationally and six laboratories nationally.

TTU has stated its interest to develop the "University spin-off Programme" for supporting the establishment of technology-based firms, based on the results of R&D projects, originating from TTU and its institutions.

The Innovation Center of TTU (TUIC) was created for:
- Active marketing of R&D projects, evaluation of the commercial exploitation potential of R&D projects originating from TTU;
- Management staff contacts and cooperation with industry, consulting and training of university staff in entrepreneurship;
- To support the development of an incubator system for start-up technology companies;
- Management of international and domestic innovation and technology transfer.

In legal terms TUIC is a foundation, constituting a non-profit entity under private law, and having founders as only privileged external decision-makers: Tallinn Technical University, Estonian Ministry of Economic Affairs (representing the Government of Estonia), Tallinn City, Estonian Confederation of Industry and Employers, Helsinki University Holding OY (Estonian Development Fund, 2008).

Many university departments have created pin-offs that enable the rapid transfer of research results to the industry. The strong involvement of commercial enterprises affects the nature of research. Since these enterprises finance the studies and are more interested in commercially applicable research, they are interested in having a strong influence on the research topics. The situation is aggravated by the attitude of the state funding system which prioritises basic research (however this influence is diminishing year-by-year). Despite such integration between industry and research, private firms still have a rather low level of awareness of research institutes and their activities (Tiits and Pihl, 2002).

Research institute-private business partnerships

N/A

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### Table 12: Current situation of the key elements of National Innovation System in Armenia

<table>
<thead>
<tr>
<th>Human Capital</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>University</strong></td>
<td>According to a recent study, the level of education has not been improved during the last decade, and even decreased. The institutions of higher education do not perform their mission of preparation and development of qualified specialists (Margaryan A. et al., 2005).</td>
</tr>
<tr>
<td><strong>Work force mobility</strong></td>
<td>Due to the large difference between the salaries of the universities/academia and enterprises, nearly 36% - 70% (depending on the specialization) of staff of universities and academia work for private sector companies (Margaryan A. et al., 2005).</td>
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<tr>
<td><strong>Infrastructure for performing R&amp;D</strong></td>
<td></td>
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<tr>
<td><strong>University</strong></td>
<td>Low level of research infrastructure, under-financing of universities, lack of necessary research equipment, low job satisfaction are areas of concern; the latter issue is very often explained by inefficient management in the field of science (Margaryan A. et al., 2005). The issues of development of young specialists and better career opportunities are of great importance as level of emigration of young specialist is extremely high. As a result, there is abnormal aging tendency in the field – the average age of scientists is 67. According to a survey, more than a half of university and R&amp;D staff under the age of 39 consider working conditions unfavorable (Margaryan A. et al., 2005).</td>
</tr>
<tr>
<td><strong>Public and semipublic research institutes</strong></td>
<td>Research institutes and universities’ infrastructure in terms of equipment, materials, communication is unsatisfactory (Margaryan A. et al., 2005). One of the most important functions of management system – fund-raising capability is absent in many research institutes and universities (Margaryan A. et al., 2005).</td>
</tr>
<tr>
<td><strong>Technoparks, incubators</strong></td>
<td>The government approved action plan 2005-2010 in November 2005 under which there is a complex of measures directed to creation and development of techno parks, advanced technological research and innovation centers, innovation data network, technology commercialization center, research and education compounds, training of specialists in R&amp;D and Innovation management (Arzumanyan, 2007).</td>
</tr>
<tr>
<td><strong>Policy and regulatory framework</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Innovation strategy and policy</strong></td>
<td>The government approved action plan 2005-2010 in November 2005, directed to creation and development of innovation system in Armenia, which suggests the following measures to be implemented in chronological order:</td>
</tr>
<tr>
<td></td>
<td>• Development of Draft Law on State Support of Innovation Activity;</td>
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<td></td>
<td>• Development and adoption of resolution on authorized state management body in the field of innovation activity;</td>
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<tr>
<td></td>
<td>• Approval of priority areas in development of innovation sphere;</td>
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<td></td>
<td>• Development of regulation on financing innovative projects;</td>
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<tr>
<td></td>
<td>• Adoption of regulation on expertise, assessment and selection of innovation projects, and procedure of formation of expert councils;</td>
</tr>
<tr>
<td></td>
<td>• Development of legal basis for creation and operation of venture foundations;</td>
</tr>
<tr>
<td></td>
<td>• Inventory and assessment of existing RTD and innovation potential and technologies;</td>
</tr>
<tr>
<td></td>
<td>• Implementation of project on study and benchmarking of best practice and international experience (USA, EU, CIS, etc.) on innovation management and development of innovation infrastructure;</td>
</tr>
<tr>
<td></td>
<td>• A complex of measures directed to creation and development of technoparks, advanced technological research and innovation centers, innovation data network, technology commercialization center, research and education compounds, training of specialists in R&amp;D and Innovation management;</td>
</tr>
<tr>
<td></td>
<td>• Further improvement of legislation on intellectual property rights, harmonization of production norms, standards and certification procedures in accordance to international approaches.</td>
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<tr>
<td></td>
<td>In May 2006 the Law on State Support to Innovation Activity was adopted, which defines legal and economic bases of national innovation policy formation and implementation, and forms of state support to innovation activity in the Republic of Armenia. The law prescribes the legal basis and hierarchy of law for the innovation activity, lists types and entities of innovation activity, stipulates state support to innovation activity stating the main goals and objectives of the state innovation policy and its main trends. As the main objective of the state innovation policy the Law mentions to be creation of favourable economic, legal and organizational environment in the country. The tasks of state innovation policy are stated to be determination of innovation policy priorities, support to technological modernization of the industry, and creation and development of innovation infrastructure, creation of legal basis for cooperation of research, education, industry and financial structures involved in innovation activities. According to the law these tasks shall be implemented through creation of favourable legal environment for establishment of venture and investment funds, providing</td>
</tr>
</tbody>
</table>
financial and investment support and state guarantees, authorization of use of state property, support to creation and development of innovation infrastructure, including research-innovation centers, foundations, technoparks, and business incubators, support to continuous training and upgrading of qualification of specialists in the field of innovation activity (Arzumanyan, 2007).

### Innovation promotion and incentives

One of the key disadvantages of Armenia’s business environment is lack of incentives and public support measures for innovative and collaborative activities (EV Research Center, 2008).

### Gov. proc-t of tech. products

N/A

### Taxation

Though the current Armenian formal tax regulation is quite liberal, the business sector reports that it is burdensome in terms of both tax rates and administration. Moreover, the system does not provide much incentive for investment in tangible and intangible assets. E.g. many Armenian technology companies that send their staff for training abroad are at a financial disadvantage due to a cap on such expenses that can be deducted from taxable income (a similar cap exists on marketing and promotional expenses) (EV Research Center, 2008).

### State institutions regulating and coordinating innovation

- In December 2000, the Armenian Parliament adopted the Law on Scientific and Technological Activity aimed at regulating interrelations between R&D performers, state bodies and R&D outcome consumers as well as outlining general principles for the formation and implementation of state policy in the field of S&T. The law prescribes the Ministry of Education and Science (MES) as the state body authorized to develop and coordinate S&T policy-making.
- The Statute of the National Academy of Sciences of Armenia (NAS RA) was approved by the government in April 2002 as one of the highest scientific organizations coordinating basic research throughout the country and the official scientific advisor to the government. It gave the Academy the status of a state non-profit non-commercial organization.
- By government resolution as of September 2006, the Ministry of Trade and Economic Development was recognized as the authorized body responsible for the development and implementation of innovation policy, in co-operation and coordination with other concerned ministries and organizations.

The aforementioned situation was indicative of the fragmented character of policy-making in S&T and innovation as well as poor interlinking and co-operation between these organizations.  

### Legal system, e.g. IPR protection

Apart from the adoption of corresponding policy measures, there is a problem of awareness of importance of such measures and laws. A study showed that most people either do not realize the importance of having IPR protection laws, or think that it’s useless for a number of reasons (i.e. incompatibility of local patent system with international standards) (Margaryan A. et al., 2005).

### R&D funding

| Private companies and Business Expenditure on R&D | Armenia’s private business sector also had very low expenditure for R&D and for employee training (less than government expenditure), in 2005 – 0.11% of GDP (EV Research Center, 2008). |
| Public funding | In 2005, total R&D expenditure was only 0.23% of GDP (EV Research Center, 2008). Government expenditure on R&D has been extremely low and negligible and below that of most competitor and peer countries in EE, the CIS and Eurasian Crossroad regions (both as a percentage of GDP and, more dramatically, in absolute terms). In 2006, R&D expenditure accounted for 0.22% of GDP. In 2005, government R&D expenditure in the country was only 0.12% of GDP, and there has been a similar ratio in the previous five years (EV Research Center, 2008). |
| Angel & Venture Capital | Armenian businesses face serious difficulties in having access to loans to undertake upgrading/new productive investment projects, and venture capital to implement risky and/or innovative projects (EV Research Center, 2008). |

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| Linkages and Networking | While there are a few successful examples of consolidation and collaborative efforts by businesses (diamond, IT, tourism, wine industries) the overall perception of the importance of clusters is to a greater extent lacking. The cluster approach is promoted by international donor organizations such as USAID and World Bank (EV Research Center, 2008). |
| University-private business partnerships | Only about 2% university staff cooperates with private sector companies (Margaryan A. et al., 2005). Only 15.8% of the cases of academia – business sector cooperation presented by respondents were indicated as productive (Margaryan A. et al., 2005). There are only a few good examples in Armenia’s IT sector, where IT companies in collaboration with universities have designed and implemented educational and training programs for training of students and employees. This refers, particularly, to programs initiated by Lycos Armenia and Synopsis together with Yerevan State University and the State Engineering University of Armenia years (EV Research Center, 2008). |
| Research institute-private business partnerships | Only about 7% of research institutes cooperate with private sector companies performing some contract projects (Margaryan A. et al., 2005). Many research institutes and universities have week capabilities to cooperate with private sector companies (Margaryan A. et al., 2005). |
Appendix B: Interview Questions

Block of open-ended questions for semi-structured interviews:

1. What is the share of the following in the firm’s production/activity in the recent years (e.g. 5 years):
   g) new products
   h) new technological processes
   i) new management (organizational/control) methods?

2. For development of which above mentioned products/processes/methods did you use the results of academic research from
   a) Armenian sources
   b) abroad?

3. What benefits do you have in the course of year derived from:
   a) sales of new products
   b) savings from new technological processes
   c) savings/improvements as a result of new management (organizational/control) methods?

4. What portion of turnover is annually spent on activities, such as:
   a) R&D,
   b) training,
   c) product design,
   d) market exploration,
   e) equipment acquisition and tooling-up
   f) work organization.

5. What sources of information relevant to innovation do you use?
   a) in the Commonwealth of Independent States
   b) in Europe
   c) in North America
   d) other.

6. Do you collaborate in activities relating to innovation with
   a) other companies,
   b) universities/academia/research institutes,
   c) governmental organizations?

7. If yes (for any or all of the above), please describe in what form, how long, etc.?
8. If no (for any or all of the above), what is the reason that there is no such collaboration?

9. How strongly is innovation in the following fields encouraged in your company?
   a) theoretical research
   b) practical application
   c) others.

10. a) How many employees are there in your staff?
    b) How many of them are PhDs?
    c) How many of them have Master degrees/Diploma/ tertiary education?
    d) How many of them have vocational education?
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