TRIPLE HELIX MODEL AND THE ISRAELI MAGNET PROGRAM: A COMPARATIVE APPROACH TO NATIONAL INNOVATION PROGRAMS WITH IMPLICATIONS FOR TURKEY

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ABSTRACT

TRIPLE HELIX MODEL and THE ISRAELI MAGNET PROGRAM: A COMPARATIVE APPROACH TO NATIONAL INNOVATION PROGRAMS WITH IMPLICATIONS FOR TURKEY

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The objectives of this dissertation are to examine science, technology and innovation policies, national innovation system and networking theories to refine the concepts and indicators for the formation of innovation networks and to identify the conditions for international innovation networks. It specifically focuses on the Triple Helix model of Etzkowitz and Leydesdorff (1994), which has brought new perspectives over the conventional models of innovation by claiming the importance of evolutionary economic activities, non-linear systemic networks and institutional restructuring for university, industry and government (UGI) relations.

The general research process of the thesis is a comparative analysis between the Israeli Magnet Program and twelve different national programs designed for innovation networks between university, industry and government. The analysis of the comparative study and the fieldwork that has been carried out among the Israeli Magnet participants during a one-year research program revealed the importance of the interaction of institutional and social indicators for the formation of successful innovation networks in Israel.

These implications are reviewed for Turkey in the context of catching-up and cross-regional collaboration between Israel and Turkey. Even though each nation experiences a unique pattern in the transition to knowledge-based economy, all of the nations are advised to apply; networking polices to utilize the benefits of knowledge-based economy. Consequently, the thesis does not claim to present a general innovation model that can be applied by any country, but rather it attempts to reach a common understanding of Triple Helix model based national and international innovation networks.

ÖZ

ÜÇLÜ SARMAL MODELİ VE İSRAİL MAGNET PROGRAMI: ULUSAL INOVASYON PROGRAMLARINA KARŞILAŞTIRMALI YAKLAŞIM VE TÜRKİYE İÇİN ÇIKARIMLAR

Göktepe, Devrim

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Bu çalışmanın amaçları bilim, teknoloji ve inovasyon (yenilik/yenilenme) politikalarının, ulusal inovasyon sistemlerinin ve ağlaşma (şebekeleşme) teorilerinin incelenerek inovasyon ağlarının kurulmasını sağlayan kavram ve belirteçlerinin açıklanması ve uluslararası inovasyon ağlarının kurulmasını sağlayan şartların belirtilmesidir. Özellikle evrimsel ekonomik faaliyetlerin, doğrusal olmayan inovasyon sistemlerinin ve üniversite, sanayi ve devlet ilişkilerinin yeniden yapılandırılmasının önemini savunarak geleneksel inovasyon modellerine yeni açılımlar getiren Üçlü Sarmal Modeli üzerinde durulmuştur (*Etzkowitz ve Leydesdorff, 1994)*.

Tezin genel araştırma sürecinde, İsrail Magnet Programı, üniversite, sanayi ve devlet işbirligi üzerine kurulu oniki farklı ulusal inovasyon programlarıyla karşılaştırılmıştır. Bu karşılaştırılmalı çalışmanın ve İsrail Magnet katılımcıları üzerinde yapılan bir yıllık alan çalışmasının sonuçları, kurumsal ve sosyal

belirteçlerin etkileşiminin İsrail'de başarılı inovasyon ağlarının kurulmasında önemini ortaya koymuştur.

Bu sonuçlar, Türkiye'nin yetişme ve İsrail ile arasındaki bölgesel işbirliği bağlamında yeniden incelenmiştir. Bilgiye dayalı ekonomiye geçiş sürecinde, her ne kadar uluslar farklı deneyimler yaşasa da, tüm uluslara bilgiye dayalı ekonomiden yararlanmaları için ağlaşma politikalarını uygulamaları önerilmektedir. Buna bağlı olarak bu tez, her ülke tarafından uygulanabilecek genel bir inovasyon modeli sunma amacı gütmek yerine Üçlü Sarmal modeline dayalı ulusal ve uluslararası inovasyon ağlarının ortak anlayışına ulaşmaya çalışmıştır.

To my dearest family

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TABLE OF CONTENTS

ABSTRACT IV
ÖZ VI
DEDICATIONS IX
ACKNOWLEDGEMENTS IX
TABLE OF CONTENTS XI
LIST OF TABLES XV
LIST OF FIGURES XVI
LIST OF ABBREVIATIONS XVII
CHAPTER 1
1. INTRODUCTION 1
2. LITERATURE SURVEY: 8
  2.1. Science and Technology Policies 8
    2.1.1. The Phases of National Science Policies 8
    2.1.2. 1945-1980s Cold War Era 8
    2.1.3. Evaluation of Cold War Era and Trends of a New Phase 10
    2.1.4. 1990s-2000s Post-Cold War Era 15
  2.2. Innovation Systems 17
    2.2.1. Innovation Economic Progress 17
    2.2.2. Levels of Innovation 20
    2.2.3. Definition of Innovation Networks 20
    2.2.4. Reasons and Motivations of Innovation Networks 21
    2.2.5. Impacts of Innovation Networks 22
    2.2.6. Functioning of a Network 23
    2.2.7. Organizational Structure of Innovation Networks 24
    2.2.8. National Innovation Systems 26
    2.2.9. National Systems of Innovation 28
  2.3. Triple Helix Model 33
    2.3.1. Definition of Triple Helix 33
    2.3.2. New Framework: Knowledge-based Economy and Society 37
    2.3.3. The Helices: “Stakeholders” 41
    2.3.4. New Roles of the Helices 43
    2.3.5. University-Government-Industry Configurations 50
    2.3.6. New Dynamic Institutional and Functional Framework 52
    2.3.7. Implications of the Triple Helix 54
    2.3.8. Importance of Triple Helix 57
    2.3.9. Conclusion on the Literature Survey 60
3. RESEARCH DESIGN AND METHODS 62
    3.1. Research Design 62
    3.2. Survey Design: Empirical Investigation 65
    3.3. Analyzing Data from Surveys 67
    3.4. Potential Implications 68

4. AN OVERVIEW ON THE ISRAELI SCIENCE AND 69
TECHNOLOGY SYSTEM 69
4.1. Israel and Domestic Facts 69
4.1.1. The Framework to Analyze Country Cases 69
4.1.2. The Case of Israel 69
4.1.3. Israeli Economic Background 72
4.1.4. Government Policies for Industrial R&D 77
4.1.5. Governmental Priorities and the OCS Support Programs 78
4.1.5.1. Domestic Programs 78
4.1.5.2. International Programs 80
4.2. Israel and World Trends 81
4.2.1. Country Specific Innovation Network Programs 81
4.2.2. Background for Selection of the Countries and the Programs 86
4.3. Comparative Analysis and Observations 95
4.3.1. International Comparison 95
4.3.2. Israel and Reference Group 96
4.3.2.1. R&D Inputs 97
4.3.2.2. Goals and Objectives 97
4.3.2.3. The Organizational Administrative Structure 98
4.3.2.4. Delivery Measure (Financing) 102
4.3.2.5. Criteria for Eligibility 104
4.3.2.6. Results and Implications of the Measures 107
4.3.3. Israel and Second Group Countries 109
4.4. General Tendencies 115
4.4.1. Lessons Learned in Developed Country Cases 115
4.4.2. Observations and Complementary Points 116
4.4.2.1. Governments 116
4.4.2.2. Objectives and Goals of the Program 117
4.4.2.3. Management Strategies and Policies 118
4.4.2.4. Bridging Institutions 119
4.4.2.5. Central Policy Themes 120
4.4.2.6. Project Initiation 122
4.4.2.7. Industry Meetings 122
4.4.2.8. Project Work 123
4.4.2.9. Technology Transfer and Dissemination 124
4.4.2.10.Evaluation /Assessment 124
4.4.2.11.Full Network 125
5. EMPIRICAL STUDY ON MAGNET 127
5.1.1. The Magnet Program 127
5.1.2. Reasons and Rationale of the Magnet Program 128
5.1.3. Participants of the Magnet Program 132
5.1.4. Organization and Implementation 133
5.1.5. Dissemination of Knowledge Outside the Consortium 135
5.1.6. Role of Cooperation and Synergy in Magnet 136
5.2.1. Assessment of Magnet 137

5.2.2. Conclusion on the Empirical Research 147
6. IMPLICATIONS FOR TURKEY 149
6.1.1. International Trends and Turkey 149
6.1.2. Turkey's ST&I Dynamics 150
6.1.3. Institutional Settings of Turkey.. 152
6.1.3.1. Research Organizations 152
6.1.3.2. Higher Education Institutions 155
6.1.3.3. Turkish Industry.. 157
6.1.3.4. Human Resources 158
6.1.3.5. Legal Measures 158
6.2.1. The University-Industry-Government Relations in Turkey 161
6.2.2. Innovation Network Framework for Turkey 165
6.2.2.1. New Role for Turkish Government 166
6.2.2.2. Academy and Industry 167
6.2.2.3. The Intermediary Organization... 168
6.2.2.4. Objectives of the Anticipated Program................................. 169
6.2.2.5. Program Procedure... 171
6.2.2.6. The Main Lesson for Turkey 174
6.3.1. Readiness for Inter/Multi National Collaboration........................ 174
6.3.1.1. Governmental Indicator: 'An active participant government' 175
6.3.1.2. Academic Indicator: 'Entrepreneurial University' 175
6.3.1.3. Industrial Indicator: 'Science-based industry' 176
6.3.1.4. Work Force: 'Skilled human resources' 176
6.3.1.5. Stability of the Program.. 176
6.3.1.6. Well-defined Market: 'Rich consumers' 177
6.3.2. Turkey-Israel Relations 179
7. SUMMARY AND CONCLUSION 182
7.1. Conclusion and Policy Implications 182
REFERENCES 186
APPENDICES 198
A. Conceptual Framework for Performance Measurement....................... 198
B. The Country Studies on Innovation Networking Measures.................. 199
B.1. Denmark 199
B.2. Finland.. 202
B.3.Ireland.. 204
B.4.Netherlands.. 210
B.5.Norway 214
B.6.Sweden 220
B.7.Canada 222
B.8.France 225
B.9.Germany 226
B.10.Japan 230
B.11.The United Kingdom.. 231
B.12.The United States of America 233
C. Figures on the facts of R&D inputs of Countries 235

D. University Government Industry (UGI) Configurations 238
E. The Questionnaire for the Magnet Consortia Participants..................... 239

LIST OF TABLES

TABLE

1. Scientist and Engineers in R&D in the Israeli Manufacturing Industry 71
2. Share of Scientist in Total Immigration to Israel, 1989-1998 75
3. The Allocation of Civilian GERD by Financing Sectors 88
4. GDP per capita in US$, using PPPs, 1999 and Population 89
5. University Industry Cooperation 1999 91
6. R&D Personnel (Researchers in Israel and selected OECD Countries 1999) 93
7. R&D Inputs 97
8. Program Objectives 98
9. Role of Government 98
10. Intermediary Bodies 99
11. Target Groups 100
12. Financing of the Program 102
13. Applicants for the Programs 105
14. Project \ Program Evaluation Criteria 106
15. Indicators of Success 108
16. Expenditure per year 109
17. R&D Inputs 110
18. Growth Rates in the Israeli Sectors 129
19. The Reasons for the Initiation of Magnet by the Israeli Government 130
20. Industrial Reason for Participation in the Magnet Program 131
21. Academicians' Reasons for the Participation in Magnet 132
22. Relations between the Participants of Magnet 133
23. Role of Magnet in the Dissemination of Knowledge 135
24. Role of Synergy in the Magnet Networks 136
25. Factors of Synergy Creation 137
26. Active MAGNET Consortia as of December 1999 139
27. The Office of Chief Scientist Budget 1988-2000 140
28. Israeli High-Tech Export 141
29. Israeli Patents Registered in the USA 142
30. The Widespread Impacts of Magnet 143
31. Changes in the Company 145
32: Possibility of this Success Without Magnet 146
33. Success of Magnet in Meeting the Demands 146
34. Participants' Satisfaction from the Magnet Program 146
35. Participants' Desire for Re-participation 147
Table A.1. Conceptual Framework for Performance Measurement 198

LIST OF FIGURES

FIGURE

1. Science Push-Market Pull 18
2. Market Pull-Market push 18
3. Interactive and Non-linear Model of Innovation Networks 19
4. New Policy formulation 29
C.1 Total Researchers-Population in Israel & Reference Group 235
C.2.Financing sectors of GERD in Israel & Reference Group 235
C.3. GDP per capita & GERD per capita in Israel & Reference Group 236
C.4. Total Researchers-Population in Israel & 2nd Group 236
C.5. Financing sectors of GERD in Israel & 2nd Group 237
C.6. GDP &GERD per capita 237
D.1. Socialist / Estatist Mode of UGI Relations 238
D.2. Laisess Faire Mode of UGI Relations 238
D.3. Triple Helix of UGI relations 238

LIST OF ABBREVIATIONS

BERD: Expenditure on R&D in the Business Sector
EU: European Union
GDP: Gross Domestic Product
GERD: Gross Domestic \General Expenditure on R&D
GOVERD: Government Intramural Expenditure on R&D
HERD: Expenditure on R&D in the Higher Education Sector
MNC: Mediterranean Nations Cooperation (EURO-MED Program)
MNCs: Multinational Companies
OECD TEP: OECD Technology Economy Program
OECD: Organization for Economic Cooperation and Development
PPP: Purchasing Power Parities
R&D: Research and Experimental Development
RSE: R&D Scientists and Engineers, Researchers
STA: Science & Technology Activities
TUBITAK: Turkish Science and Technological Research Institute
TUBA: Turkish Academy of Sciences
TTGV: Turkish Technology Development Foundation
SBS: Supreme Board of Science of Turkey
(The international abbreviations-acronyms for countries and for national programs are mentioned in the thesis.)

CHAPTER 1

1. INTRODUCTION

In today's global world of innovation, knowledge and learning have become strategically important factors that foster competitiveness and socioeconomic growth. Globalization, international information exchange, and strong competition impel all stakeholders of society to participate actively and promote the role of knowledge within the socioeconomic system as early as possible. The timely possession or non-possession of knowledge and skills and the full utilization of the knowledge capacity of partners will determine national welfare and prosperity. However "deficits and backlogs, especially concerning the structure of the system, lead to heavy burdens and can only be remedied at the highest expense" (Tubke, 1999, p.1). Networking between the users and producers of knowledge has been proposed as a way to remedy the systemic structural problems and to generate more power from the synergy of participants.

Regarding this argument, the objectives of this thesis is to first present a literature survey on the science, technology and innovation policies and innovation networks theories. Especially the research evolves into Triple Helix model of Etzkowitz and Leydesdorff (1994), which states the university, industry and government (UGI) relations in evolutionary economic activities, non-linear networks and institutional restructuring. Second, in light of this theoretical framework, this dissertation is aimed at first to find out the success of innovation network building within the Israeli MAGNET program, which has been initiated by the Office of Chief Scientist (OCS) in 1991 to support pre-competitive R&D within the consortia of academy and industry. Subsequent to this is to identify its impacts and importance on Israeli socioeconomic and industrial affairs. The third aim is to make a comparative analysis between the Israeli program and programs from Denmark, Finland, Ireland, Netherlands, Norway, and Sweden as reference group countries. Additionally, the main features of the measures from Canada, France, Japan, the United Kingdom and the United States of America are presented to strengthen the comparative analysis. Regarding to the results of the comparative analysis, the final objective is to identify the indicators for the formation of innovation networks and derive lessons for the belated countries specifically for Turkey. The identification of these indicators indicates not only innovation networks at the domestic level but also signifies the conditions for international R&D cooperation.

The rationale behind this procedure is based on the fact that: although it is a common belief that nation states have experienced different economic patterns and have different capacities and traditions in science & technology systems, there is still the possibility of mutual learning from success and failures in addressing common objectives (OECD, 1999). Thus the redesign of the national institutional settings eliminates the disconnection between technology producers 'academy or developed countries' and users 'industries and developing countries'. This research dissertation is anticipated to fit to the general theme of Triple Helix, which states the importance of "Breaking Boundaries, Building Bridges" among the states (4^{th} Triple Helix Conference Announcement, 2002).

Traditional, neo-classical economics does not understand networks. It is based on rational actor model that has the perfect information in making decisions; thus it does not make sense to have external partners. However as globalization reveals the transaction costs, it became a must to minimize these by internalizing them (Sweden, Wamp Report, 2000). Innovation networks and national innovation systems have been acclaimed as accurate models for science & technology systems of the twenty-first century (Freeman 1987; Rullani 1988; Lundvall 1988; Dosi 1988; Nelson, R.R 1993; Rosenberg 1993; Patel and Pavitt 1994; Teubal et al. 1994; Gibbons et al., 1994; Carlsson and Stankiewicz 1995; Metcalfe 1995; Etzkowitz and Leydesdorff, 1995; Edquist et al., 1997).

Although non-linear models of innovation, systems of innovation and Mode 2 state importance of networking as well, a 'Triple Helix' of academia, industry, government relations and a spiral model of innovation diffusion likely to be a key component of any national or multinational innovation strategy of the twenty-first century. Thus despite different historical patterns, Triple Helix based innovation strategies can be admitted as the most viable method for both industrialized and industrializing world of twenty-first century (Gulbrandsen in Etzkowitz and Leydesdorff, 1997). Therefore the research is built on the work of innovation networks and Triple Helix, which has been already done, however it takes it further by conjecturing the possibility of recursive modeling of the model by the latecomers. It makes a comparative analysis among developed countries and states their policies are much more complementary and interconnected to each other than the policies of developed countries and developing countries. It looks the probability of customized modeling of these indicators by developing countries and the attainment of interconnections and regional clusters among developed countries and developing countries.

The data for the contextual framework are gathered from a "textual- comparative analysis" on existing literature on national innovation systems. For the analysis of the Israeli Magnet Program the data are collected through the fieldwork that is done in Israel among the Magnet Consortia participants. Additionally, the data of the Central Bureau of Statistics in Israel are extensively used. As information base for the rest of the models the OECD figures and statistics, European Trend Chart of Innovation and Internet sources for the national science and technology programs are employed. Between these two sets of data, "statistical and comparative analysis" are done in order to figure out the uniqueness and / or similarities of the Israeli model vis-à-vis the world models.

This thesis is organized as follows; Chapter II presents a descriptive and comparative analysis of innovation networks and the Triple Helix Model. Chapter III presents the research methodologies for the case studies and fieldwork. Chapter IV analysis the Israeli science and technology dynamics and it compares the Magnet Program with other models. Chapter V presents the empirical research on the Magnet Program and evaluates the survey results derived from the fieldwork. In Chapter VI the attention shifts to the analysis of the Turkish science and technology (S&T) contexts and academy, industry and government relations. This chapter analyses the results of the previous chapters and determine some implications for Turkey. The concluding part presents a concise summary of what has been learnt and an overall evolution of the thesis.

As to provide a lay out for the theoretical examination of Triple Helix model, the literature survey is organized on the logic of paradigmatic shifts in science and technology policy making and state the necessity to proceed to Triple Helix. Therefore, it starts with a brief examination of S&T policies of nation states since the end of World War II to the current developments. It tries to identify the reasons for these shifts. Second, it discusses the trends of the 90s as trends towards a final phase, and the needs for the formation of innovation network policies sole S&T policies in this final phase.

As the literature on innovation networks are too vast to deal with, the second section is organized into subsections of innovation and economic progress, definitions, reasons, impacts, operation and organization of innovation networks. Ultimately the national systems of innovation models and Mode 2[1], which try to analyze the contemporary university, government, and industry relations from a networking perspective, are highlighted.

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1 (Mode 2, which takes the firms as the main actor of innovation network and claims a relative decline in the role of universities are examined in details in section 2)

As a final paradigmatic shift in innovation policies, the third section of Chapter II is focused on the assessment of the Triple Helix model. It examines the Triple Helix model with regarding its consideration of the new framework knowledge-based economy, the actors of the system, the functional implications between them, and the Triple Helix configurations with regard to each mode of production. It refocuses on the new network framework from the evolutionary dynamism of economic relations, after analyzing the helices and the interaction among them.

In addition to this theoretical analysis, it presents the new perspectives of the Triple Helix over the previous innovation models. In light of this analysis, it presents an evaluation of the new perspectives and insights that have been suggested by the Triple Helix over the 'traditional' or preceding models.

Chapter III presents the research design of the thesis. It states the research goals, research questions, and the design of field survey. It clarifies the statistical methods that are employed for the analysis of the questionnaire that is done among Magnet participants. Additionally, it presents the potential implications of the research as well.

The aim of the Chapter IV is to assess Israeli S&T dynamics in a historical perspective. First, it briefly discusses the economic and industrial background of Israel, and then highlights the Office of Chief Scientist support programs. Next, it presents a detailed comparative analysis between the Israeli Magnet Program and twelve different national programs on networking. The national networking positions and the organizational, financial structures, project eligibility criteria, target groups and the outcomes of these networking programs are compared. On account of the limited national data on the direct outputs of the programs, the analysis of contribution of measures is based on the general satisfaction or dissatisfaction from the programs. Nevertheless, they can be employed as viable criteria since the outcomes are considered as the social and economic objectives that can only be realized when the direct outputs of these programs interact with society and economy (Jaffe, 1999, p.69, Table A.1 in Appendix). Moreover Shefer et al. (2000) also emphasized the societal dimension and direct or indirect long-term benefits of technology transfers. This comparative analysis highlights the general tendencies and success determinants of national innovation programs to be employed for the subsequently as to design of the questionnaire and derive implications for Turkey and international networking.

Chapter V presents the evaluation of the results of questionnaire submitted to the Magnet participants. It makes the descriptive and statistical analysis for the evaluation of the questionnaire. It aims to assess socio-economic and industrial contribution of Magnet to the Israeli society. In the light of these results, it examines the formation of Magnet from the Triple Helix perspective and reconsiders the prominence of Magnet in meeting domestic needs and world trends.

Chapter VI discusses the results of the above analysis. It first tries to draw some complementary points for Israel, presents a satisfactory description of innovation network; then it tries to infer some lessons that can be contemplated by the catch-up countries, particularly Turkey. It endeavors to derive implications for the innovation policies for Turkey to form its networked organizational structure. For this configuration, the internal dynamics and innovation potency of Turkey are examined in order to find out similar and contrasting features of the two countries. Accordingly, the main question of this thesis is to find out correspondences between the Israeli and the Turkish systems.

Chapter VII presents the evaluation of theories on innovation networking. It concludes the study by emphasizing the importance of triple innovation networking for both national and international economies. It tries to find out the general determinants for innovation networking. Clearly, this thesis is not aimed at offering a general innovation model valid for all countries because of country-specific development patterns and different internal dynamics. The main motivation is to reach a common understanding of innovation networks according to Triple Helix patterns, which provide an effective way to utilize the opportunities of knowledge-based economy. The examination of different country programs and deriving implications from their experiences will enable policy-makers to formulate their own Triple Helix based innovation path. This will enable different countries to bypass the national differences and to be organized from the similar perspectives with the projection that in the long-run the boundaries between national innovation systems will diffuse and lead to regional innovation systems and global knowledge flows.

In the appendices a comprehensive presentation of the twelve country experiences are included. The country programs are reviewed from EU country reports, EU Trend Chart on Innovation, Internet sources on national science and technology programs, OECD reports and figures.

CHAPTER 2

2. LITERATURE SURVEY:

Science -Technology and Innovation Policies

2.1. Science and Technology Policies

2.1.1. The Phases of National Science Policies

Science and Technology Policies can be defined as policies that are designed to (i) influence firms to develop, commercialize, or adopt new technologies; (ii) to influence universities to continue their basic research facilities with the commercialization activities. The aim may be wealth creation, economic or military competitiveness. The policy tools include macroeconomic regulatory instruments, tax incentives, and network initiation among the partners.

For centuries, governments have pursued policies to improve the innovation performance of national industry, and to strengthen wealth creation of national resources. Many of these policies were used to be impelled by the pressures of military competitiveness and national security; recently the policies have started to be driven by economic and economic motivations. This shift can be reflected as the S & T policies of Cold War era and post-Cold War era (Muldur and Kostas 1999).

2.1.2. 1945-1980s Cold War Era

To a certain extent, the history of the Cold-War S&T policies can be divided into three main phases that were not experienced in sharp boundaries all over the world or at the same time. The creation of knowledge has been on the agenda of nation states since the Cold War. The national science agenda has evolved from non-interventionist forms of research sponsoring to that of interactive partnerships between funder and researcher for the creation of knowledge (Jacob et al., 2000).

Phase 1 is the period of 1945-70s. It focused on the science and military competitiveness relationship, and it was designated as the 'policy for science'. This period is characterized by the writings of Vannevar Bush (1945), in his famous letter to President Truman, and in Alvin Weinberg's arguments (1967), (Jacob et al., 2000). The Cold War 'Power Elite Societal Mode' of Mills (1958), in which the military formed the third element of an institutional triad with large industry and executive branch of government, also reflects the first phase. This is mainly reflected in the USA cold war strategy as the exploitation of science for military competitiveness and security. The US Department of Defense and NASA allocated huge amounts of money for 'Big Science' (Von Tunzelman, 1995). Science was considered as a strategic national resource. Europe also followed this path, and many of the government intervened to direct science for national competitiveness and security (see Figures D.1, D.2 in Appendix, p.234).

Phase 2 is relatively shorter than the former phase. The oil crisis and the recession of the 70s made policy makers think about utilizing science for resource creation and economic use beyond the military competitiveness. In that period none of the countries were economically strong enough to drive the world economy. The Brooks Report to the OECD by Harvey Brooks (1971), articulating the 'science in policy' concept, paved the new way in the S&T policies (in Branscomb et al.1999). This report emphasized the importance of science for development. This was the extension of phase 1 activities to include "tapping the research capacity to support economic development" (Jacob et al. 2000, p.256). This was achieved by bringing the state research programs and private sector research initiatives. This shift was represented in the 1971

Rothschild Report in the UK, the Research Applied to National Needs (RANN) Program in the US, and the Scandinavian "Sector Research" Program. Subsequently, this phase led to the development of trans-disciplinary academic knowledge fields such as innovation and science and technology policies.

Phase 3 S&T policies were designed to tackle the continuation of the worldwide recession of the previous times. The economic recession of the late 1970s and early 1980s in all of the industrialized states led to the reassessment of the notion of science as the engine of economic performance but was still carried out in isolation from the social environment within which it might be applied. The technological base of the major economies was depleted; thus the infrastructure needed to be supported. This need was met by the introduction of science parks and innovation relay centers to bring public researchers and their industrial counterparts or business clients together (Jacob et al 2000). The idea behind it was that the closer spatial proximity between industry and the university would facilitate the interactive knowledge creation. The national programs, including the 'Alvey drive in the UK', and the supra national 'EUREKA and ESPRIT European programs', and the National Science Foundation role in developing Industry-University Cooperative Research Centers and Experimental R&D Incentives Programs (ERDIPs) in the USA (Gray and Walters, 1998) reflect this policy trend.

2.1.3. Evaluation of Cold War Era and Trends of a New Phase

Science and technology policies of the Cold War era lost ground; they are no longer viable methods for the social and economic needs of the 90s. The insufficiency of these three phases can be attributed to two sets of reasons. The first set is mainly connected to the Mertonian normative view of science, which states science grows best when decisions are left to scientist. However, as science has become a strategic resource, science should be steered outside of the scientific community as well, so that it will produce socioeconomic benefits

(Jacob et al., 2000). Secondly, external evaluation of university science agenda is needed for the social accountability of science. This made academicians and non-academicians to be involved in the knowledge generation as opposed to Mertonian view of science.

Other feature is the relationship between industry and academy was based on sponsorship rather than a partnership or collaboration. This disposition posed the following impediments in formulating an extensive S&T system for economic achievements (Jacob et al., 2000, p.256). Subsequently, when government's funding decreased the academic research decreased as well during the Cold War era.

During the times of Cold War, S&T policies were to some extent downsized in the scientific research process and in the general public policy mechanism. This was connected with the naive belief of the 'linear model of innovation diffusion' that basic research in university and public laboratories will create knowledge which will be turned into commercial products and processes easily and subsequently will yield economic growth.

Secondly, technological knowledge, or the results of scientific knowledge have been assumed to be fully codified. However, they cannot be codified easily, on account of the 'tacit factor' of the knowledge. It means the uncodified, personnel knowledge and skills make the transfer and application difficult (Polanyi, 1967). Thus, the technological knowledge is often highly specific to a single organization sphere or individual. In other words Mowery (1995) states that organizations are required to be involved in the earlier stages of technology development because of the organization-specific know-how that is accumulated through previous research, production, or use.

Another problem that has been disregarded during the past three phases is both the public and private aspects of technology make it require not only subsidization but also adoption and competition polices from the government.

A further problem is the definition of the boundaries of technology policies. These conflicts rise over the inconsistent goals of the technology producers and users, which seem to be impossible to be linked. Such as the conflict over (i) the creation, versus diffusion of new technologies; (ii) centralization and rationalization of R&D activities versus diversification, duplication and decentralization of R&D; and (iii) static allocative efficiency versus dynamic structural change (Jacob et al., 2000).

The second set is related to the current trends that happened in the last decade. Such as the end of Cold War, put the economic objectives in a superior position over military ones. Moreover, the slowdown of growth in the US and Europe, the rise of Japan, the elevation of Asia Pacific Basin’s technology intensive industries and their strategic technology policies and the increasing international economic competitiveness. (Movery, 1995; Nelson, 1996).

Furthermore, due to the decreasing state funds, universities have started to look for new financial resources. Universities have been transformed from sole teaching and research function to economic activities. This is considered as the ‘second academic revolution’. A further trend is the corporations replacing their own R&D activities with short-term contractual agreements for R&D with universities. Thus, not only academy seeks partners to commercialize its ideas, industry looks for original, creative ideas of academy. The outcome of these trends is the acceptance of knowledge as the motor of economic progress and heterogeneous but clustered sites of knowledge production (Jacob, et al. 2000).

By and large, the pressures of globalization, the widespread use of information communication technologies, emergence of knowledge-based economy and society have made knowledge creation as an interactive and cooperative process of communication and negotiations between different partners. The economic progress has become knowledge-based. At the national level there occurs a convergence among the actors of society economy and politics: university, government, industry need to work cooperatively.

Since the mid 1980s, it has been observed that the rapid increase in scientific and technological knowledge provides social and economic progress, in as much as they are exploited successfully and turned into innovation. Innovation became a key driver of economic growth, job creation, and sustainable development. Thus, innovation has gained policy attention, and how R&D could be tied more directly to needs in companies and markets has become a main policy focal point for industries and governments.

As Kline and Rosenberg (1986) argue that the linear model of innovation process that has bolstered the traditional approach to technology policy is not sufficient to explain the scientific and technological progress. Since the innovation process is not a sequence of phases or steps, rather it is a set of activities, which are linked to one another through complex feedback loops. Moreover Mahdjoubi (2000), classified the innovation models as the First and Second Generation of Innovation Models, which were policy justification of cold war science policies, based on the assumption of linear flow and technology push and market pull are now too simplistic to describe the current trend. 'The Third, Fourth and Fifth Generation of Innovation Models', which are based on the networks integration and complex interaction with continuous feedback of the actors has been acclaimed as the proper model for the innovation process.

Therefore, the impediments above and the recent trends have been further accumulated into four problematic issues that need to be tackled. The first is the "productivity paradox" that developed countries have experienced through the 1970s and it has been exacerbated since these economies became more and more reliant on the improvement of science & technology. It is the failure of aggregate productivity to grow in response to investments (Von Tunzelmann, 1995). It is the benefits of the science and technology investments increase at unproportionally lower rate with a unit increase of science and technology investments (Dosi, 1988; Perez & Freeman, 1988; Krugman, 1996; Nelson & Romer 1996; Rosenberg 1996; 1982; Conceicao, Heitor & Olivera 1998 in Kim 2001).

Second problem relies on the relative decline of Fordist (Mass) production system. Since the production system of future requires intensive use of technology and 'flexible specialization' (Piore & Sable, 1984; Shimada 1991). Third point is the "under-utilization of the science system", which means the lower use of the capacity of university, research centers and industry for economic progress and social benefits is considered to be another factor (Duinen, 1998, p.383). A final problem is the OECD countries have experienced a gradual decrease in the supply of science and engineering students, which has been indirectly linked to students' preference of private sector rather than research positions (OECD, 1989; Pearson, 1990 in Kim 2001). Science-society contract needs to use new concepts such as Triple Helix to analyze the change closer linkage between universities, industry and public institutions. This linkage is considered as the inevitable result of these developments.

On the other hand, both the market economies and the socialist economies have been facing a structural / systemic problem related to the governmental role in economic affairs. While in the former model, the lack of state intervention caused a lack of networking or coherence in S&T. In the latter case, strict state control led no room for bottom-up initiatives from the academy or industry to express the market and social needs. These economies need a new paradigm to deal with the current trends and to solve the above problems. Networking has been proposed as a way to cope with these problems and for the full utilization of the opportunities of knowledge-based economy.

This paradigm shift paved the way towards “innovation network formulation”. For this end, both developed and developing countries ought to strive for a network building between the producers and users of technology. Therefore, innovation networks and national innovation systems have been acclaimed as accurate models for the science, technology and innovation systems of knowledge-based economy. (Rullani 1988; Metcalfe 1990; Lundvall 1992; Sandholtz 1992; Nelson 1993; Oh & Masser 1995; Etkowitz & Leydesdorff, 1995; Porter 1998, and OECD Report 1997 EC 1995 as cited in Kim, 2000).

2.1.4. 1990s-2000s Post-Cold War Era

The policies in knowledge-based economy aimed at innovation networking, and management of innovation system as a whole. Thus, the public policies are required to be adapted to these changes; even the governments need to make systemic structural changes to strengthen the innovation capacities in order to take the benefits of knowledge-based economy. This has resulted in a stronger focus on how to facilitate or improve cooperation, communication between the users and producers of the innovation for wealth creation. Correspondingly, the academic studies on interrelationships of innovation, competitiveness and economic growth (Schmookler, 1966; Rosenberg, 1972, 1976, 1994; Nelson & Winter, 1982; Freeman, 1974; 1990, Freeman et al., 1982; Jorgensen 1996; Bertuglia et al. 1997 as cited in Shefer et al. 2000) have become a growing subject. Additionally, the models of innovation emphasizing the users-producers networks for further economic development have also gained great prominence among various theorists (see e.g. Kline & Rosenberg, 1986; Gibbons et al., 1994; Ziman, 1994; Etzkowitz & Webster, 1995; Etzkowitz & Leydesdorff, 1997).

Jacob et al. (2000) concede that the emergence of the knowledge society has inaugurated the fourth phase in university industry relations and they described it as the "knowledge partnership phase" (p.357).

Moreover as Gibbons et al. (1997) stated that new economic system is based on cross currents, countercurrent and even riptides, which give impetus to progress and wealth creation instead of a single strong flow. By the same token, Dodgson (2001) states progress and development can be accomplished in the forms of strategic research partnership, such as technology-based joint ventures, strategic alliances and multi-partner R&D projects for the generation and diffusion of technology and extension of industrial development.

In addition to these theoretical statements, the 1999 OECD report on Managing National Innovation System clarifies that systemic approaches are giving new insights into innovative and economic performance in the OECD countries. In this phase, states have started to pursue innovation policies beyond S&T strategies. Formerly, they have intervened in the technology arena to address market failures that impede the flow of technology. However, in knowledge-based economy, governments have been compelled to be involved in the innovation process since the initiation, instead of intervening irregularly to adjust markets.

Governments need to integrate partners of innovation system in a cooperative way. They need to secure the conditions that are conducive to innovation. They need to create synergies between public and private sectors. Hitherto, technological performance was measured by inputs (R&D expenditure and personnel) and outputs (patents new products); in knowledge-based economy the level and density of interactions, fluidity of knowledge flows among the actors involved in innovation process determine the innovative capacity of a nation. The broader applications of these outputs into social and economic needs are considered the outcomes and performance of this innovation system. Hence, the more intense innovation partnerships and more interactions between public and private sector, the more technology and wealth are created. Heretofore, states performed S&T policies; yet the trends of knowledge-based economy caused governments to make Innovation Networking Policies, phase four policies evolved around partnership, and linking the different partners of society for innovation.

However, concluding collaboration of the different partners of society for innovation generation as the main policy strategy is a bit blurry. Thus, the following section provides concise but comprehensive analysis on innovation and economic progress; establishment of innovation networks; and two systemic approaches analyzing the university, industry and government relations in innovation networks.

2.2. Innovation Systems

2.2.1. Innovation Economic Progress

Invention is the creation of new technological knowledge; it is a "new idea, sketch, or model for a new or improved device, product, process or system" (p.15). Innovations are new creations but having significant economic benefits. It is the embodiment of this new knowledge in production process; it is accomplished only with the first commercial transaction involving the new product, process, system or device. They may be brand new or new combinations of existing technology (Schumpeter, 1943, Norris and Vaizey, 1973, Freeman, 1987, Edquist, 1993).

Innovation can be regarded as the total process of the inception of an idea, into the production of a product and finally to its ultimate sale. It is translation from invention, research, development, production and marketing.

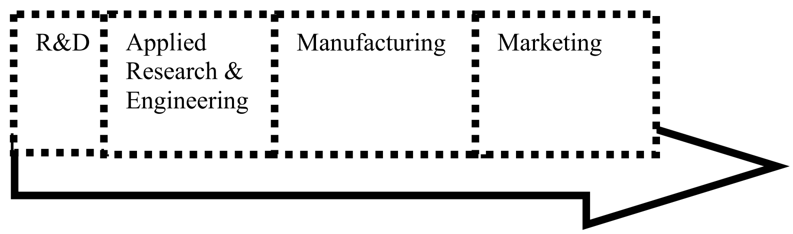

Figure 1. Science Push-Market Pull

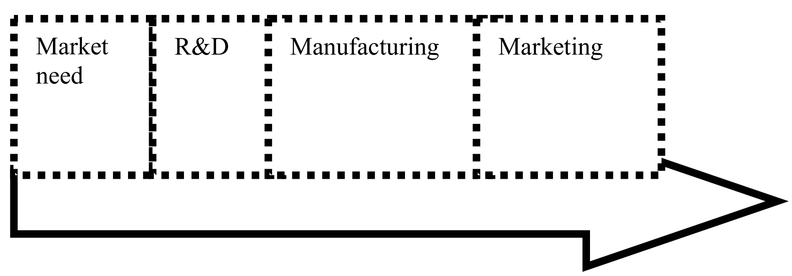

Figure 2. Market Pull-Market push

However, this translation is not a linear path as shown in Figures 1 and 2, it is characterized by feedbacks and interactive relations of science, technology, production, marketing, and policy-making (Edquist, 2000). The ability of nations to convert ideas into new commercial products is fundamental to its socioeconomic development. Thus, technological knowledge has become economically useful when it is turned into innovative products and process within an efficient network of university, industry and government, which channels individual creativity towards collective goals (OECD, 1999). Yet an efficient network can be established through the involvement of these and other potential actors in all of the phases of innovation from R&D to commercialization.

Innovation is the successful development of new products, process and ideas (Gilbert et al., 1999). Today's complex business environment requires much more iterative and interactive innovation process, which involves both different institutions and functions. Thus, the economic success depends on effective innovation networks. For this end, states have started to formulate innovation policies, beyond S&T policies. It has been defined as a set of financial and non-financial instruments and institutions to encourage domestic industry to undertake more and more R&D and to commercialize them (Leyden and Link, 1992 as cited in Mani 2001).

Interconnection between universities and market has become a crucial factor in achieving economic and social benefits from technological advances. Hence, when market and non-market institutions do not interact properly, technological progress will slow down and its contribution to economic growth will diminish (OECD, 1999). In sum performance and capacity of innovation depend not only on how independent actors (industry, research institutes, universities, governments) perform, but also on how they interact with one another and how much they produce as elements of an innovation system at local, national, international levels.

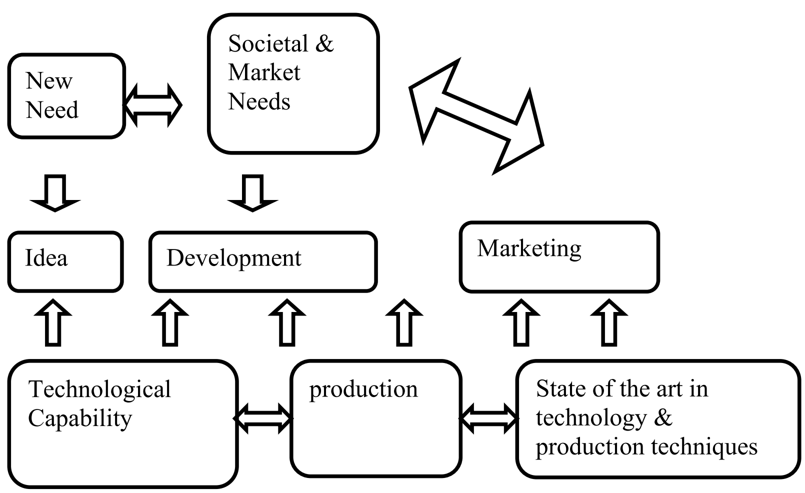

Figure 3. Interactive and Non-linear Model of Innovation Networks

2.2.2. Levels of Innovation

Amidon (1997) identified five levels where innovation process is progressing. In the first phase, the technology is transferred as a discrete movement of technology from laboratories to industry, in second phase the importance of the exchange of knowledge among people is recognized. In the next phase, the ideas and knowledge are developed jointly and new capabilities are gained as a result of the interaction. In the fourth phase, systematic approaches are adapted to manage the innovation process.

Finally, knowledge and innovation networks are formed. Different strategic partners come together, with different as well as mutual focuses and interests. Hence, innovation becomes a dynamic process of networks of different participants.

2.2.3. Definition of Innovation Networks

Despite national variances in most of the industrialized and industrializing states, the underlying feature of the S&T policies of the global era is the trend towards formation of innovation networks. It may be in the form of "strategic research partnerships, technology-based partnerships, strategic alliances or multi-partner R&D projects" (Dodgson, 2001, p.1).

In general innovation networks can be defined as both formal and informal linkages among universities, public research institutes, industry (whether large or small-medium enterprises), political actors and agencies, aimed to generate synergy between them to achieve greater success in innovation and thus socioeconomic progress. It is a shared commitment of resources and risk by a number of partners by bringing together their sources of knowledge and skills often in innovation networks or in new combinations (Freeman 1991; Debresson and Amesse 1991; Skyrme, 1994; Gilbert et al 1999; Kim, 1999; Dodgson, 2001).

2.2.4. Reasons and Motivations of Innovation Networks

Although the main reason of innovation networks is to contribute to economic progress, there is a wide range of explanations for why different institutional bodies form innovation networks and thus how they subsequently achieve economic progress. Bozeman & Dietz, (2001) mentioned that understanding of the importance of and benefits of networks leads to the understanding of their function or "raison d'être". According to corporate perspective, the uncertainty and imperfect information about the market prevent the partners from allocating resources in an optimal way.

Therefore, the uncertainties, because of information gap, assessment gap, competence gap, control gap, can be eliminated by bridging the different partners' knowledge and skills (Mowery, 1988, Dodgson and Rotwell, 1994, Kodamo 1995 in Dodgson 2001). Moreover, Dodgson (2001) emphasized economic reasons like cost reduction and strategic economic relations for competitor exclusion. Secondly, technological issues related to the technology life cycles, decreasing the time to introduce new products and some qualitative matters such as organizational learning as the further reasons for the formation of innovation networking. Hagedoorn et al. (in Dodgson, 2001) classified three main traditions that explain research partnerships: reduction of transaction costs, achievement of strategic management, and competitive industrial organization as the reasons behind innovation networks. Furthermore, Samulat, (1999), mentioned the contribution of innovation networks in providing both financial and management consultation to small and medium sized enterprises (SMEs). Finally, national innovation networks provide "flexibility" and "efficiency" to the system where there is under-utilization. Instead of relying on foreign technology or mergers, domestic resources will be utilized. Large-small firm, university-industry interaction can be facilitated for further achievement of the potential of each of them. All of these reasons behind the formation networks will extensively aimed at curbing the risks of economic investments and reducing the any kind of cost.

2.2.5. Impacts of Innovation Networks

Concerning the above arguments, it can be generalized that innovation networks based on ‘positive sum gains’ aspirations of partners. They act mutually to acquire more benefits and gain more from the networks than they could achieve independently. Skyrme (1994) identified the benefits of effective networking as follows, faster development of new products and services; better optimization of R&D expenditures; better anticipation of customer, and market needs; better utilization of national resources. Mowery (1998), defined the potential benefits of strategic research partnership as enabling member firms to appropriate knowledge spill-overs, which would otherwise be lost, eliminating the duplication of R&D expenditure, speed up the commercialization of technologies, facilitate the transfer of technology from university to industry.

Gilbert et al. (1999) added the importance of interactive learning on the network partners such as, acquisition of new abilities for new capabilities, replacing both abilities and capabilities with new ones, and performing exceptional research and innovation instead of normal results. Furthermore, Hagedoorn, Link, and Vonartas (2000) pointed out the importance of access to complementary technologies, learning of tacit knowledge, expansion of product range, entering to new markets (in Bozeman and Dietz 2001). On the other hand, the real impact of interactive learning is argued to be difficult to be measured (Dodgson, 2001).

There may be also adverse aspects of networking such as being anti-competitive, too exclusive, and having entry barriers. The research results may be contained within the consortium members; the transfer and diffusion of technology may not take place at the desired rate. Moreover, firms may rely on so much external technology, instead of increasing internal potentials (Hobday, 1994 in Dodgson

2001). Nonetheless, the positive impacts will likely to overweigh the negative outcomes of networking.

2.2.6. Functioning of a Network

The motivations and the cognizance of the partners about the benefits of innovation networks are not sufficient conditions for networks to emanate and to function. Innovation networks require a systemic management approach that incorporates innovation models and integrates the elements of business strategy, information and knowledge resources, information technologies, organizational cultures and structures, human and psychological factors, and performance evolution for their functioning (Skyrme, 1994). Through the incorporation of these various factors, systematic management seeks to create synergy among the participants.

For this end partners need to share collaborative cultures for further learning. Second, as it operates on across institutional boundaries, it needs developing networking structures and bridging mechanisms. The traditional structures and rules need to be modified into less hierarchical structures to allow innovation to prosper. Moreover, Amidon (1996) and Skyrme (1994) mentioned the intense application of information communication technologies to amplify the share of knowledge among the participants as well as diffusion into the society and economy.

On the other hand, Himple 1987, Hamel et al. 1989, Lynch 1990, Powell 1990, Levy & Samuels 199, Koschatzky & Kulicke 1994, Gibson and Rogers 1994, NBIA 1997, (as cited in Kim, 1999) referred to the conditions that may impede the functioning of networks. They stated when (i) there is no adequate trust among the participants; (ii) there is no convergence on the long term goal among the participants; (iii) participants expect no interactions for future projects; (iv) there are communicational barriers in sharing information-knowledge and conflict over the intellectual property and financial benefits, it seems unlikely for the actors of society to form innovation networks.

Thus for a proper functioning of innovation systems, the necessary changes in institutional structures of the system regarding all the internal and external factors need to be done. Besides this, the obstacles that impede the establishment and persistence of networks should be eliminated and conducive conditions and key institutions need to be contrived.

2.2.7. Organizational Structure of Innovation Networks

The participants of innovation networks can be integrated vertically or horizontally. However, as Gilbert et al. (1999) stated networks are complex self-organizing multi-level structures, generally with no central control. They are characterized by elements of trust, cooperation, openness and self-organizational forces. Beyond the traditional theories of pluralism, corporatism, networks require close interactions between politicians, scientists, technologists, industrialists and customers. In some occasions, it reshapes the institutional, political and societal setting of nations completely.

Generally, two modalities have been mentioned in analyzing the university, industry, and government networks: bottom-up and top-down approaches (Duinen, 1998; Sutz, 2000). The first modality is based on the identification of relationships established between certain actors in need of knowledge to solve a problem and other actors capable of translating the problem into knowledge terms and conducting R&D to find solution. After the identification of any kind of problem by one of the actors, they look for partner to solve it, and eventually a third party may play a bridging role between two sides. The actors are supposed to be able to conduct dialogue about the nature of the problem; they need to understand each other's culture of problem solving for successful innovations. Faulkner and Senker (1995) and Ferraro and Borroi (in Sutz, 2000) pointed out the importance of a common language and trust in facilitating triumphant knowledge relations.

The top-down approach is institutional design of university, industry, and government relations. It is centered on the role of new agencies designed for the management of these relations. This type of cooperation is generally initiated by governments by some laws at national or regional level and developed in different kind of agencies within ministries.

Within the innovation networks, the institutional spheres should have equal rights in the management of innovation process. Even tough one of them may have more central role in initiating the process, during the process every one needs to participate and benefit equally. Thus within the networks itself, there should be a reconciliation of both approaches, while it may be initiated with governmental rules and bodies, there should be some room for bottom-up initiations so as to be more responsive to the needs of society. Hence with a proper functioning of networks neither governments and society will lose time and money by anticipating industry, academy will match each other within the dynamism of market, nor the industry and university will lose due to the lack of regulatory mechanisms of innovation.

Concerning these statements, factors of trust, frequency and level of interaction, satisfaction from this interaction, collaborative relations, longer-term reliability of relations, formation of equity and balance among the participants, consensus over intellectual property rights (IPRs) can be considered as important variables to determine the feasibility of innovation networks. In addition to these, the motivations for their formation, their impacts on the participants and the whole socioeconomic life, conditions for their functioning and organizational structures of innovation networks can be used as indicators to analyze innovation networks. On the other hand, the exclusive or inclusive characteristics of networks or consortiums, the accessibility of non-partners to access the new technology, and the intensity of the diffusion of technology can further indicate the success and contribution of networks to the society. Thus, these are crucial parameters to analyze the innovation networks and to find the feasibility of successful innovation networks in the empirical research.

2.2.8. National Innovation Systems

As the innovation process covers the whole phases from R&D to marketing, innovation policies need to cover these phases. Innovation policy includes science-educational, technology and industrial policies at the same time. Consequently national innovation system policies are introduced to analyze the relations between these three types of policies and the relationship between the stakeholders of innovation networks as discussed above. The stakeholder refers first to the executive bodies, which are governmental agencies, ministries, research institutes; second to the industrial and business organizations, and the higher education sectors, universities, and researchers.

The policies are designed to establish production, organization methods, tools, inputs and intellectual physical capacity for the establishment of innovation systems with the participation of all stakeholders. National innovation systems aim to (i) enable nations to make efficient R&D management programs; (ii) provide effective learning and education system; and (iii) produce, develop, and design new innovative products and processes. National innovation systems include education, industrial, political and economic systems of nations. In this sense, the production of new knowledge is no longer a process of trial and error of variation and selection; it is a coordinated process of innovation and recursive learning. Knowledge is no longer obtained from outside the system; rather it is generated within the system. It involves many actors, and the number of actors is determined by the uncertainties of the periods, technological complexities, legal issues, risks and public consciousness, which are unique to the internal dynamics of each nation.

This has induced an evolutionary change in the area of knowledge production and technology diffusion in addition to the alteration in the roles of the institutions. Universities and industry, up to now relatively separate and distinct institutional spheres, are assuming tasks that were formerly largely in the province of the other. Thus, universities are looking to commercialize research while industry is looking to provide training and to contract out its research. The role of government in relation to these two spheres is changing. They are pressing academic institutions, to go beyond performing the traditional purpose of, education and research, and allowing greater flexibility for partnership with industry and make a more direct contribution to wealth creation, and financing industrial R&D partnerships (HMSO 1993). As Baruch Raz Science Counsellor at the Israeli Embassy in the UK states, good policies can only work with capital support. Thus in the 1990s, none of the states can hold up under the risks of subjecting the Science-Technology-Innovation Policies to the invisible hands of market forces or strict state regulations.

This change leads to a new paradigm in science, technology and innovation studies (Ahrweiler, 1999). The analyses of "national systems of innovation & Mode 2 and Triple Helix" are two mainstream tendencies that have been suggested sequentially trying to analyze the new socioeconomic configuration and to convince all actors to be involved in innovation activities. These two theoretical frameworks concerned with this new paradigm, and investigating the innovation process within the structures and dynamics of interaction networks (Ahrweiler, 1999) and emphasizing the university-industry-government relations. While the former one "national systems of innovation" based on "externalities and spillovers" effect the latter one "Triple Helix" is based on "competitiveness" of the structure.

2.2.9. National Systems of Innovation

Justman and Teubal (1986) have identified 'tactical-development of technologies- and infrastructure- facilitation of innovation-'elements of S&T policies. Recently Freeman (1987), Lundvall (1988-92), Porter, (1990), McElvey (1991), Nelson (1993) have organized this infrastructure aspect into a more extensive concept of National Systems of Innovation. Metcalfe generalized what they all suggested as " national system of innovation is a set of distinct institutions, which jointly and individually contribute to the development and diffusion of new technologies, and which provides the framework within which governments form and implement policies to influence the innovation process" (Metcalfe, 1995, p.460). According to Freeman's research, Bengt-Ake Lundvall was the first person to use the term National System of Innovation. Yet Freeman and others all admit that the first systematic and theoretical attempt to focus upon national systems of innovation goes back to Friedrich List's (1841-1959) conception of "The National System of Political Economy" and von Hippel's work on informal technical collaboration among firms (Freeman; Lundvall, as cited in Edquist, 2000).

Freeman (1987) states it as the network of public-private institutions for initiating, producing and diffusing new technologies; Lundvall (1992, in Edquist, 2000) adds the institutional setting as affecting the learning, searching and marketing. He also pointed out the institutional setting depends on historical patterns. Even though national innovation systems may vary from country to country, they "encourage policy makers to think in terms of institutions and their connectivity to shift the innovation possibility frontier of firms" (Metcalfe, 1995, p.468). It is the system of interconnected institutions to create, store and transfer knowledge, skills and artefacts for innovation and wealth creation.

OECD (1999) report states the theoretical foundations of National Systems of Innovation are as follows. First, it is based on the main assumption of New

Growth Theory that is the importance of increasing returns to knowledge accumulation from investment in new technologies and human capital (Romer, 1990; Aghion and Howitt, 1998). Second, evolutionary and industrial economics assert this accumulation is a path-dependent process, which is non-linear, following technological trajectories, and is shaped by various organizations and institutions (Metcalfe, 1995).

Third, institutional economics provide issues related to the design and co-ordination of institutions and procedures to handle the increasing interdependencies and specialization of tasks and tools (North, 1995).

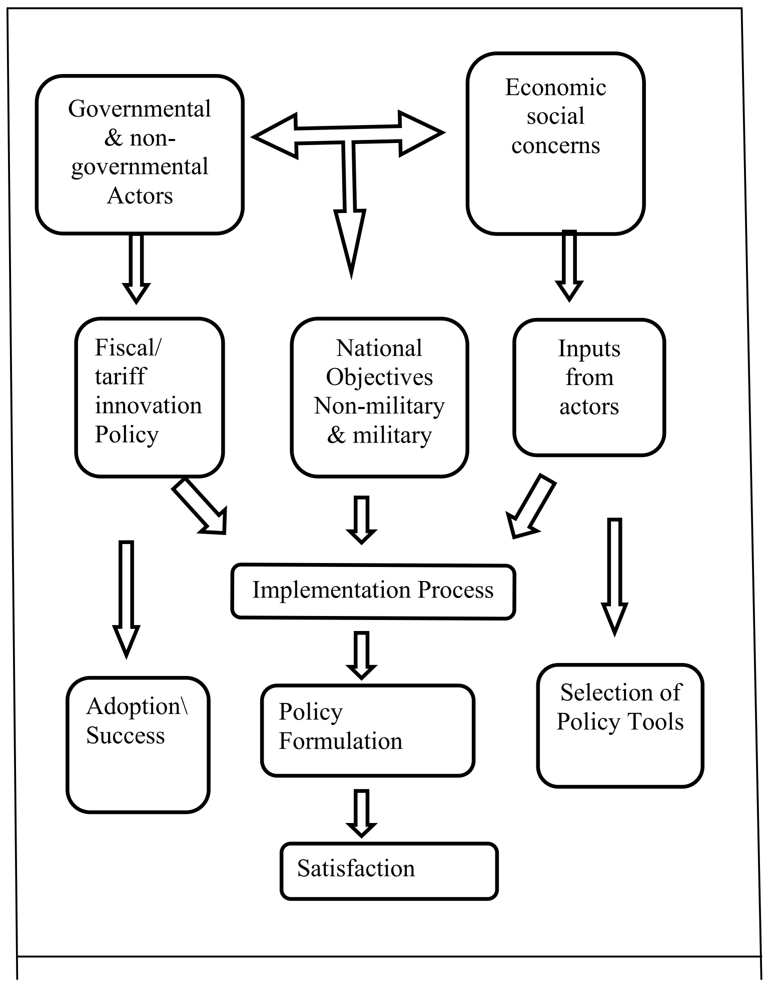

Figure 4. New Policy formulation

Involvement of institutions is central in this model. First the formation of network of institutions, and establishment of an institutional set-up, then the importance of institutions and mechanisms in generating innovation, lastly the role of specific institutional infrastructure in the creation, diffusion, and utilization of technology are significant features of the new policy formulation for especially S&T (Freeman 1987; Lundvall 1992; Nelson and Rosenberg, 1993; Carlsson and Stankiewicz, 1995 in Edquist, 2000).

This is an interconnection of different institutions, such as cooperation among educational bodies, professional organizations, industrial research groups, public and private research centers to create, store, and transfer the knowledge, skills and equipment. They focus on the national policies, regulations, language and culture and the important roles of governments as to bind the system together. Principally, in national systems of innovation, “private firms with an explicitly defined R&D function” are the primary actors in the generation of technological artefacts, and for applying them in the search for competitive advantage (Metcalfe, 1995) and particularly in the development of tacit knowledge (Pavitt, 1987 in Metcalfe, 1995). In contrast, academia is less concerned with development of artefacts, and only contributes in terms of knowledge and skills. Thus firm activities are required to be supported by the knowledge and skills of educational and research centers.

This system based on division of labor. The “component institutions make complementary contributions to the innovation process, but they differ significantly with respect to motivation and with respect to dissemination of the knowledge they generate” (Metcalfe, 1995, p.465). The connectivity is achieved via mobility of scientists, and technologist; collaboration agreements, grants and contracts for research. Concerning the informal links, Lundvall (1998), and Andersen (1991) mentioned the importance of links between user firms and their suppliers, while Von Hippel (1988) and Schrader (1991) emphasized the “balance of trading of knowledge between the engineers of different firms" (in Metcalfe, 1995, p.465).

These informal networks are considered to be important routes for technology transfer and transfer of tacit knowledge. The boundary between them is almost shattered, however Dasgupta and David (1987, 1991) have emphasized incompatibility between science and technology system. While the former one is not profit motivated and has different priorities like higher education, basic research, and knowledge dissemination, the latter is profit oriented, works with relatively on short-term results, and opposed to unrestricted public disclosure (in Metcalfe, 1995).

National systems of innovation state an interface between these two worlds concerning the effective transition of scientific knowledge into product and process development activities of firms. Yet, even management of this interface poses a number of difficulties such as the "distribution of creative talent between the two worlds, … the balance between research and skill formation in higher education, … links with and sponsorship from industry undermine the openness and development of basic science" (Metcalfe, 1995, p. 467).

Besides the above discussion, Gibbons and his colleagues (1994) moved further and stated the 'Mode 2 innovation Model', which is characterized by constant flow between basic and applied knowledge. It is different from the 'traditional or Mode 1 knowledge' production (Jacob et al., 2000). The authors rightly stated heterogeneity and organizational divergence in knowledge production; "knowledge is no longer produced only in university settings, but is also produced in different loci, like government laboratories, industries, and think-tanks. Knowledge tends to be produced in different contexts of application (p.85). Definitely this refers the first attribute of Mode 2, in which knowledge is produced through "a process of continuous negotiation of the needs, interests and specifications of all the involved actors" (Jacob et al., 2000, p.11-27). This distinctive feature differentiates Mode 2 from "consultant or commissioned research arrangements" between industry and academia. However Gibbons et al. (1994) neglected the details of negotiated character of the process of knowledge production, which is though the most important qualitative difference between Mode 1 and current knowledge production. A second feature of Mode 2 is the transdisciplinarity, which means the gathering of a "diverse team of specialists to work on a problem, and transdisciplinary knowledge, which creates its unique theoretical structures, research methods and modes of practice" (Gibbons et al, 1994, p.5). A final feature is the dissemination of knowledge in the process of production in which practitioners move from one context of application to another, rather than publication and conferences.

In sum, knowledge is produced in non-hierarchical, heterogeneous, flexible organization. Still and all as in the national systems of innovation; they take the industry as the main actor in the creation and diffusion of innovation and universities will comprise only a small part of the knowledge production (Gibbons et al, 1994, p.85). Thus, they claim while diversification of knowledge production centers makes firms central and leads to a decline in the role of universities. Furthermore, Mode 2 emphasizes beside the peer review process of project evolution, "social acceptability, and market competitiveness" of projects determine acceptability of projects. Social accountability of science and responsiveness of science to social needs are further mentioned.

Though systems of innovation brought new and complementary directions to the needs of knowledge-based economy, they fall short within these perspectives. First, 'management of interface between science world and technology world' or 'research teams' is not clarified sufficiently, thus the reconciliation of the clash of cultures and interests of stakeholders, involvement of stakeholders as well as the 'negotiated character of knowledge production' and the 'ability of research teams to act cohesively' have been left unsolved (Jacob et al., 2000). Second, the diffusion of knowledge is to be achieved by the mobility of members from one context of application of to another; however, it is not an easy task due to the demarcating boundaries between them. As a result, the ability of practitioners to transmit tacit knowledge from one context to another is rather unattainable.

Third, since knowledge is produced in the context of application, social accountability is limited to the willingness and consciousness of project members (Jacob, 2000). Finally, although firms are considered to be the central actors in knowledge generation, they need to be supported by academia. Innovation cannot be limited and reduced to the level of firms. It needs to be applied in wider context.

The other tendency Triple Helix is far from suggesting any decline in the role of none of the actors (Godin and Gingras 2000). Instead, they stress enhanced and evolutionary roles of the actors, along with new potential players to meet the internal and external dynamism of the knowledge-based economy. Correspondingly, they underline the social, political, economic contexts and historical patterns of each state will determine who will play the outweighing or initiating role, without dictating the others.

2.3. Triple Helix Model

2.3.1. Definition of Triple Helix

All these developments and the insufficient sides of Mode 2 and systems of innovation caused a new contract between university and the society. The former one based on a linear model of innovation, which assumes only long-term contributions of academic knowledge to the economy and latter is based on non-linearity. However, recently, economy has become capable of grasping the both short-term and long-term benefits of the basic research. Triple Helix model states a "spiral model of innovation, which is able to capture multiple reciprocal linkages at different stages of the capitalization of the knowledge" (Etzkowitz and Leydesdorff, 1997, p.1). In this system all the partners are supposed to be involved and act interactively in the innovation process from the beginning till the end. Triple Helix model analyses the transition mechanism in this complex set of interactions.

Triple Helix has been suggested by Etzkowitz and Leydesdorff in 1995. They took an analogy from the Double Helix of DNA structure (Watson & Crick, 1953)[2]. As the biological model implies, this is an evolutionary model. The main thesis of Triple Helix is the involvement of university, industry, and government in the process of innovation. It is a "triad of inputs" into innovation framework. (Gubrandsen, 1997, p.124).

The Triple Helix attempts to account for a new configuration of institutional forces emerging within innovation systems. It better explains the management of science and technology world, knowledge diffusion, social accountability and acceptability of science and the level of involvement of each actor in the innovation process. These three institutional spheres which formerly operated at 'arms' length' in liberal capitalist societies are now increasingly working together, with a spiral pattern of linkages emerging at various stages of the innovation process, to form the so-called 'Triple Helix (Viale, et al., 1999).

Nonaka and Takeuchi have emphasized the importance of the spiral mode of knowledge creation as "the participants in the network start the "spiral of knowledge" through socialization, developing a new field of interaction. Through dialogue and collective reflection, they force externalization, i.e., they articulate the hidden tacit knowledge and establish concepts. These newly established concepts are combined with the explicit existing knowledge and then create a new product, service or management system (systemic knowledge). The actors internalize the newly established concepts and ideas through "learning-by-doing". This innovation, in its turn, will spread out over the actors taking part in the process and it will be internalized by them. From this internalization, the tacit knowledge of the innovation's user appears and it will be shared with all the participants in the network, improving the same product or creating a completely new one (product, process or service).

Triple Helix takes the traditional forms of institutional differentiation among university-industry-government as its starting point, and adds human factors of the evolutionary perspective to this structure, which is reflexively reshaping these institutions (Etzkowitz and Leydesdorff, 1997, p.155). The theory based on these arguments, which are also main indicators of new economy: 'evolutionary theory of economic activity, non-linearity, user-producer interaction, institutional linkages, network of institutions, interactive learning and learning economy and the expansion of mobility of employers among different organizations, the intensive interaction and communication among the organizations'.

The originators of Triple Helix stated that Triple Helix bases on political science to define the S&T policy issues in general terms. Secondly, it has a sociological perspective to explore the impact of scientific and technological developments on the academy & industry. Additionally, it has an evolutionary economic perspective to analyze and manifest the impacts of evolving knowledge infrastructure on industrial system, university, government, and industry relations. Fundamentally, their basic premise, which is the evolving structures of helices within it and among each other, and thus the dynamism of the system, is grounded on the general evolution concept.

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[2] Double helix can unzip itself and carry the life's hereditary information, US, National Academy of Sciences

While evolutionary economists such as Nelson and Winter (1982) and Andersen (1994), have considered the firms as the main unit of analysis of innovation, since firms are bridging the basic science and commerce; the policy makers have focused on national systems of innovation as to analyze government role. On the other side, David and Foray (1994) argued the importance of networks as more abstract unit of analysis (in Etzkowitz and Leydesdorff, 2000). Beyond these the authors (2000) conclude that all these perspectives lead to the appreciation on the dynamic and complex process of innovation from different views. They point out a system that is composed of sub-dynamics of 'market forces, political power, institutional control, social movements, technological trajectories and regimes', and 'integration of these sub-systems'.

Triple Helix states the integration of this sub-dynamism will lead to the expansion of knowledge generation within the infrastructure of the society. In order to analyze this dynamism, Triple Helix identifies two differentiations. First is "the functional differentiation between sciences and markets; and second is the institutional difference between private and public control" (Etzkowitz and Leydesdorff, 1997, p.156). In time the 'cross-tabulation' of these spheres leads to a model of technological development in terms of university, industry, and government relations. Triple Helix aims to analyze the binding forces among autonomous, yet tightly connected, institutional arenas. These increased interactions led to the generation of new structures within each of them, as well as integrating organizations and hybrid organizations like incubator facilities. Moreover as Freeman and Perez (1988) emphasized technological innovation might require the reshaping of an organization and community, thus innovation networks may inevitably result in a wider reshaping of the society (in Etzkowitz and Leydesdorff, 2000). They draw a very dynamic innovation framework, which gets its dynamism from the ongoing transformations within and between each of the institutional spheres (helices) and in their functional roles.

Therefore, while the evolutionary economics focused on the co-evolution of these institutions, technological trajectories and selection environments, Triple Helix endogenizes the knowledge infrastructure of society as a next-order regime. It states the co-evolution of three dynamics is rather complicated and unstable compared to the co-evolution of trajectories or the stabilization of double helix in a biological system. The new system is in transition; it is unstable and contains uncertainty. David and Foray (1994) argued that under these conditions, irreversibility, lock-ins in inferior technologies, crises are not uncommon and helices may absorb energy instead of generating it.

On the contrary, Triple Helix modeled innovation networks are complex enough to accommodate these chaotic behaviors. The helices mutually shape each other, and communicate by selecting upon the variations in and interactions among the other ones (Leydesdorff, 1994, in Etzkowitz and Leydesdorff, 1997). This is a process of creative destruction (Schumpeter, 1939 in Etzkowitz and Leydesdorff, 1997). The system recovers itself from its tendency to disintegrate by new configurations.

2.3.2. New Framework: Knowledge-based Economy and Society

Triple Helix assumes a final convergence of the economic and political and educational actors in the new economy. Etzkowitz and Leydesdorff (2001) state three main sources of contextual transformation. First source is the expansion of interconnection between the knowledge-production centers and the factories. Second factor is the emergence, spread and convergence of information and communication technologies such as the computer, mobile telephony, and the Internet has made cross border interaction more extensive among organizations. Final point is the transition from vertical to lateral and multi-media modes of coordination, made the emergence of horizontal networks, and made pressure on the bureaucratic layers to shrink. Correspondingly, this trans-formative change requires a structural change in the institutional setting of the states.

Etzkowitz and Leydesdorff (1997) rightly argue that Triple Helix modeled science, industry and politics will be the key strategy of national or multinational innovation agendas of the new century. Viole et al. (1999) also acknowledged that the convergence and crossing-over of these three worlds: public research, business and government, which has been represented by Etzkowitz and Leydesdorff (1995), as Triple Helix model became the dominant trend of 21st Century. Fujigaki and Nagata (1998) pointed out that although S&T policies and the relations between university, government, and industry were used to be shaped historically and culturally, these systems are now re-configured according to Triple Helix Mode of Etzkowitz and Leydesdorff.

Etzkowitz mentioned the model of military, the US federal government and corporations have been replaced by a new set of tripartite relations between academy, industry and government, focusing on civilian competitiveness. Gulbrandsen (1997) asserted that the relation between these three sectors for the knowledge-based economic development and innovation partnership in Nordic countries fits this model (in Etzkowitz and Leydesdorff, 1997). Plonski and Albertin (1995) and Sutz (2000) also stated the government initiations in Latin America for the establishment of innovation networks composed of academy, industry and public. Additionally, Sutz (2000) also stated the pattern of formalization of the university-industry cooperation, devotion of funds for joint R&D projects between academia and firms were already recognized in Latin America.

Furthermore the study of Larèdo (1997) on the effects of technological programs of EU upon member states' research policies (from Alvey Drive to ESPRIT, EUREKA, Framework programs) showed the tendency of governments support of innovation networks between industry and academia and for new structural arrangement (Etzkowitz and Leydesdorff, 1997). Low (1997) also pointed out that though Japan claimed to be an example of the "wisdom of privatizing science", 1993 recession and decline of industrial funding let government to enhance the R&D capacity of universities and establishing links between industries to meet the challenges of knowledge-based economy (Etzkowitz and Leydesdorff, 1997, p.132). Likewise, Turpin and Garrett-Jones found out that the ongoing transformation of university, industry, and government relations are common phenomena to two different countries China and Australia. Furthermore, Gingras et al. (1997) remarked that in the past two decades Canadian governments have focused on the need for stronger ties between university and business, and the policies and strategic programs for the promotion of university industry relations (Etzkowitz and Leydesdorff, 1997).

In all of these innovation programs, knowledge is assumed to be the main motor of economic growth. However, for steady growth, nations need a heterogeneous market of knowledge producing organizations composed of different stakeholders with different values, but with a shared commitment. The cooperation between them is a must for the functioning of the system. This new partnership system requires integration of different stakeholders around the mutual aim. On the other hand integration brings different interests, values, and cultures of the stakeholders to the system. They argue this system is pulled by integration and diversification forces, hence they provide the expansion and dynamism of the system. They consider this constant dynamism endows the system with endless progress as long as the interaction and communication among the helices are organized properly.

However, albeit Triple Helix is the common trend how much government intervention is needed or how much a university has to reach out, are not evident, the originators and contributors of the model stated the internal dynamism of states would determine these relationships. The central issues of level of integration, intervention, capacity of networks and hence the optimization of the system depends on "different traditions of political economy, and different levels and types of economic development" (Etzkowitz and Leydesdorff, 1997, p.3). They restate the two types of government involvement in economic affairs. First is the interventionist etatism in which the nation states encompass academy and industry. This is the failed experience of former USSR, Eastern Europe and in some Latin American states. Secondly, the non-interventionist, free market economy cases of Sweden and the US where there are strict boundaries among the actors. Finally, Etzkowitz and Leydesdorff have configured Triple Helix, as a knowledge infrastructure in terms of overlapping institutional spheres, and with each of them taking the role of other and paving the way to form hybrid organizations at the interfaces.

To some extent, knowledge-based economy nullifies both socialism and capitalism, thus Triple Helix can be taken as the social, economic and political model of knowledge-based economy.

These two former models faced such problems: In the market economies, industries declined to invest in big R&D projects, since they believed that they could not capture all benefits of creation of knowledge, and knowledge can be reused by others at zero marginal costs. In addition, academy either suffered from declining state funds for R&D projects or they could not commercialize R&D, especially in US before Boyl Dole Act of 80s (Hasegewa and Furtado, 1999). On the other side socialist economies used to have universities and industry as a part of the same institutional sphere under the aegis of government was expected to transfer technology (Mello et al. 1998, in Etzkowitz, et al, 2000). However there was always a gap between them and they underestimated or missed to utilize these developments as social and economic goods. Furthermore, though developing countries have been pursuing of policy of self-sufficiency, they have been suffering from object and idea gaps, as well as bridging their potentials for better utilization eliminating the gap between them.

Triple Helix model outstrips previous models of whether laissez-faire or socialist, in which academy plays a subsidiary role. It accounts for a new configuration of the interaction of institutional spheres within the new innovation system. Triple Helix emphasizes each nation needs to find its optimum system to balance the forces of integration and diversification- in order to provide further innovation and wealth creation. Etzkowitz and Leydesdorff identify the prevalent trends in the roles of the stakeholders even though each nation starts from a different base. A non-zero-sum relation has to be organized by government agencies between academia and industry. For this end the actors of the system, their roles, interaction among them and the impacts of this relationship on the whole system are analyzed in the following parts.

2.3.3. The Helices: "Stakeholders"

What are the new elements of this new system which will initiate and regulate innovation networks? What kind of relationship among them can be established? Where may they come together?

In their first study, Etzkowitz and Leydesdorff (1995) identified three main institutional spheres or sub-dynamics; namely, university, industry, government, and each of them considered being one of the helices. In their more recent study they added the emergence of network organizers and coordinators, as knowledge brokers and academic research centers. These are considered the integral parts of the network system in bridging the helices and translating the different values between different domains, along with them, getting people used to work together and share knowledge. They function as linking each helix with another and assisting the formation of interfaces between them.

Gibbons et al. (1994) and Nowotny et al. (2001) suggested the declining role of university due to the occurrence of consulting firms and knowledge brokers. However, Etzkowitz and Leydesdorff (1997) claimed that these new bodies would rise and disappear within the dynamism of the knowledge and innovation production. Indeed this concept is not so new. Brooks (1970s) defined *buffer institutions* as bridging the inherent gaps that may impede partnership between industry and academia. These institutions are connected to universities where students and faculty could participate in real world problem solving, but they are independently organized and managed and have their own core staff, with different career lines" (in Branscomb & Heller, 1999, p.384). They could translate the academic research to the point, where small and medium sized firms can easily adopt.

Moreover, Rotwell (1986) defined the "technological tailor" concept as referring the "top industrialist who may prefer to establish links with a smaller but highly innovative firms that have a market niche in designing, building and operation of customized solutions" (in Sutz, 2000, p.279). However, the critical point is that as technological tailor has links with academia, it provides the accommodation, adaptation, and harmonization of two sides, and further establishes a triangular relationship. It acts as a '*gatekeeper'* between the industry and academia.

Furthermore, Duinen (1998) stated that the assumption of direct link between science and commerce is inaccurate. He pointed out that there is science cycle and business cycle. However, science is hardly able to produce goods and services without the skills and initiatives of business. Therefore, there is a need to maintain the dynamics and quality of science through the operation of multiple funding mechanisms. Finally, Lissenberg and Harding, (2000) put forward that in between academia and institutes, there are academic research units representing a compromise, by gathering elements from each of the partner. The university has created new categories of researchers that are neither professors, nor students, nor technicians. Universities hire permanent senior staff without faculty status, and they are moving toward the 'Institute Model'. Therefore, these cases show the necessity of collateral organizations in bridging institutional spheres, rather than causing any decline in any of the partner.

The elements of the system are the agencies of government and other public sector bodies, prominently universities and other science-intensive institutions, and the various players in the private sector. The core element of a national system is therefore, constituted by a country's institutions such as university, government, industry and non-governmental organizations, academic, private research center and potential body in the inter-relationships of the production, diffusion and use of new and existing knowledge (Marceau and Dodgson, 1999).

Second, they specify three main functional sub-dynamics of institutional layers over the helices. First is the retention mechanism for economic wealth; second knowledge generation and production; final is the application of best practices from public or private control (Leydesdorff, and Etkowitz, 2001). In other words, it is the utilization of the most favorable legislative system for the functioning of innovation process. However, in time of interaction and communication these helices are assuming new roles as well as the roles and functions of another consistently.

2.3.4. New Roles of the Helices

The analysis of new roles will clarify why they consider the actors and their functions as sub-dynamics of the system and the justification of Triple Helix for the constant dynamism of the new system.

Following the Cold War the 'Power Elite' trilateral mode of Wright Mills (1958) lost its ground. The military considerations decreased and thus the university-government-industry relations have been transformed into a less hierarchical network of 'pluriform society' (Leydesdorff and Etzkowitz, 2001). Moreover, in the knowledge economy, for a continuous improvement of innovation the critical success factor is the facilitation of knowledge flow among academy- industry-government, in such a manner that all sides gain profits from this knowledge partnership.

The dynamics of interactions among the participants are complex; they can alter their positions in response to the system as well as in relation to each other's position. Hence, from the analysis of network perspective, the functions of organizations become uncertain and they are required to be redefined.

Viale et al. 1998 (p.1), described these new functions as "Academic researchers become entrepreneurs for their own technologies as entrepreneurs working in university laboratory or technology transfer office. Public researchers spend time working in a company. Academic and industrial researchers manage regional agencies responsible for technology transfer". Moreover, for the institutional level they identified the 'hybrid agents of innovation', such as university hi-tech spin-offs, or venture capital societies set up by universities, which are responsible for the production and use of knowledge and are hybrid forms of interaction between university, business and government. In addition to this, they defined innovation coordinators that are responsible for coordination and management of the various phases of innovation activity.

Thus, in Triple Helix the institutional spheres of university, industry, and government, in addition to performing their traditional functions, each assume the roles of the others. Universities are creating an industrial penumbra, or performing a quasi-governmental role as a regional or local innovation organizer (Pires and Castro 1997, Gulbrandsen 1997). An intermediate level of agencies and small enterprises has become typical for the 'post-modern' research system (Rip and Van der Meulen, 1996).

The institutional innovations, generally stimulated by governments aim to promote closer relations between faculties and firms. "The Endless Frontier" of basic research funded as an end in itself, is being replaced by an "Endless Transition" model in which basic research is linked to utilization through a series of intermediate processes (Callon 1998 in Etzkowitz and Leydesdorff, 2000). Triple Helix states that in order to achieve intermediate processes, in both industrial and industrializing countries, governments and their agencies are needed to play a pervasive role in performing, funding, facilitating and influencing knowledge production and diffusion activities.

Governments' functions include operating its own research laboratories and financing universities, providing scientific and knowledge infrastructure and offering grants or other support for particular public research projects. It provides the legal and regulatory framework for knowledge production and exploitation, for example in relation to intellectual property, research ethics or the safety and standardization of particular technologies. Government may also encourage the business sector to undertake an appropriate level of technology development or use and training. Governments and political system need to develop new codifications to make the use of public resources possible and legitimate for further development of the Triple Helix. It becomes the main function of governments to structure the exchange systems for mutual learning, rather than just its direction (Etzkowitz and Leydesdorff, 1997, p.160). This new structuring requires a fine mixture of market exposure and protection. The states as well as the other actors need to balance these forces.

However, it is not an easy task to tackle the mixture of publication and protection, since the asymmetrical process has replaced the 'symmetrical' socio-cognitive interaction of sociology of science. Who will be the legislative body? Alternatively, who would be the liable person in case these consortiums or innovation networks have financial loses? These are critical points, and supposed to be solved within the dynamics of innovation networks.

In sum, governments should foster industry-science partnerships, linking the universities and local industries in order to ensure a sustainable flow of knowledge and contact between universities and industries. They should reshape the laws of the higher education institutions in terms of favoring the universities to forge partnership with industry or establish their own start-ups. Therefore, governments need to promote public-private partnerships to encourage innovation. For this end, they need to set an institutional framework with consideration to the priorities and demands of all partners. They need to use some financial incentives (tax exemptions, subsidies) to assist the private sector investments in science and technology. Moreover, they should raise the public awareness in the benefits of industry-university cooperation.

They need to formulate new more elastic working rules, than the former models or systems, which allow joint working between academy and industry. The modern university emerged in nineteenth century after the 'First Academic Revolution'. It is the transformation from being largely institutions of higher education to undertaking research and teaching as well. Currently, increased international competition, the end of Cold War, and awareness of knowledge-based economic development and the declining state funds for universities triggered the Second Academic Revolution. These challenged the Cardinal Newman's traditional 'ivory tower' vision of an independent community of scholars and institution (Etzkowitz, et al., 2000). Triple Helix pays great attention to the new role of university in formulating the network of university-government-industry. Universities play a greater role in industrial innovation as provider of 'human capital, seed-bed of new firms,' and creators of new knowledge.

Economic affairs used to be an activity of either industry or state depending on the social system, in knowledge-based economy universities became the key element of development. As channeling knowledge flows into new sources of technological innovation has become an academic task, it caused a change in the structure and function of university. This flow is achieved in "technology transfer offices, incubator facilities, and offices of managing intellectual property rights, research parks and interdisciplinary research centers with industrial participation. Additionally, many schools formulated procedures to deal with the conflicts of interest and commitment as faculty members play dual roles" (Etzkowitz, 1999 in Branscomb et al. 1999, p.209).

Godin and Gingras (2000) also stated that, universities have centered in industrial innovation since the mid 90s as focusing not only R&D activities but also technology transfer to industry. In this new environment, universities are required to change their mission and they need to adopt a wider vision of forging links with industry. Thus besides their traditional roles of teaching and research, they started to undertake some business activities, such as establishing their own start-ups, utilizing their basic research as patent rights.

Etzkowitz identified four types of entrepreneurial scientist. The *mogul* is institution-builder; aiming to acquire financial rewards and translates research idea into a marketable product. The *sustainer* is a modest institution-builder. The sustainer's goal is the creation of a firm with a marketable product that can bring sufficient funds to the research program. The *adviser* is not an institution-builder; he/she is willing to receive lesser financial rewards. They provide the initial concepts and contributing the firm's development. Finally, the *craftsperson* that intervenes into the entire process of R&D to commercialization is the essential type of actor in sustaining research partnership.

Consequently, as traditional disciplines intersect with new structures, the entrepreneurial university develops into a matrix organization, away from traditional departments and subjects of teaching and research. The university takes on multiple roles; in due course, it reorganizes its resources to focus on new problems, both intellectual and practical, with research and service units such as centers overlapping teaching faculties. Thus instead of any decline in the role of universities, they attained a greater role due to the transformation of system into knowledge-based economy. To catch up with this transition the "economic function of university is increasingly institutionalized in addition to differentiation between higher education and research" (Etzkowitz, 1994 in Etzkowitz and Leydesdorff, 1997, p.158).

Modern entrepreneurial university is the "amalgam of teaching and research, applied and basic, entrepreneurial and scholastic interests" (Etzkowitz, et al, 2000, p. 326). Conflicts between these elements are solved in a creative tension of reconciliation and compromise. This reconciliation can be achieved by the combination of Mertonian view of science and entrepreneurial values for the capitalization of knowledge and for helping the elimination of the tension between knowledge as a public good or private good (Arrow, 1962; David and Foray, 1995 as cited in Etzkowitz, et al., 2000).

On the other hand faster pace of technological development and "downsizing of firms to core competencies made companies to become more receptive to external sources of innovation" (Soete, 1991 in Etzkowitz and Leydesdorff, 1997, p. 2). Moreover as new industrial competition requires more and more knowledge-based products and services, industrial competitiveness depends more and more on academic knowledge production through either accessing university R&D results and staff or establishing their own R&D labs still in cooperation with academy. Industry takes on some of the values of the university, sharing as well as protecting knowledge; research groups of firms collaborate with public and university research groups to achieve common long-term strategic goal (Etzkowitz and Leydesdorff, 1997).

Industry leaders must understand the development of practical results from the university research takes years. Thus the benefits from R&D activities may not be instant, contains risks and surprises. Industry leaders are required give-up to short–term profit maximization policies, and they should be committed to the long-run R&D dynamism. The critical point is the clash over the intellectual property rights. While industry and business lives require competition and secrecy over the new ideas, academic reputations based on the dissemination and mobility of knowledge. This matter is to be solved within the dynamic structure of Triple Helix as well as application of both public and private practices into innovation process.

Finally, the division of tasks between the public sector and the firms becomes blurred. Especially when it comes to developing human resources, there is a strong need for co-operation and interaction. However, it is also true that private firms will have a strong interest in the efficiency of the public sector since framework conditions become crucial for their performance. Besides the public sector needs to take a much stronger interest in the dynamic efficiency of private firms. In spite of being exposed to competition the resistance to change – for instance, in the direction of building learning organizations – is strong also at the top level of many private organizations.

On the other hand, Benner and Sandström (2000) pointed out the importance of new roles of research councils, which were used to act on be half of state, are now play a vital role in the "redirection of the normative orientation and actions of individual researcher within the new organizational field" (p.294). They can also reproduce existing routines, halting or hindering the transformation of the institutional order and organizational field. Moreover, they concluded they are important in redirecting academic work towards commercial applications and achieving industry-university collaboration.

Etzkowitz and Leydesdorff (2001) conclude dynamic transformation in which: (i) university can take the role of industry by initiating start-ups and undertaking incubator facilities; (ii) government can act like industry by subsidizing and funding industrial activities; (iii) finally industry can perform academically as regards to development, training and research as high level as universities. Firms start exchange of knowledge and personnel among them as well as between the helices. Faculty members participate in industrial activities or vice versa. Industries help scientists to commercialize their ideas and provide them with marketing-business skills. Universities may find new sources of funding, new opportunities for graduates, and new directions for research. Correspondingly, industry gains from the access to new ideas generated at universities and research institutes, graduates, and to the physical facilities of universities, laboratories, etc.

All these changes induce changes in the structure of society. The boundaries among the components of society became elided and replaced by web of ties. However, as new arrangements take place, the old settings are still utilized for the creation of complex interplay among organizations. New institutional structures are the combinations of diversified sources, emerging from the networks of university, industry, and government in order to generate and diffuse technological knowledge into society.

2.3.5. University-Government-Industry Configurations

Mobile Disappearing or Balanced Boundaries between the Stakeholders:

By and large, Triple Helix brings a new market friendly organizational setting. Similar to the statement of New Growth Theory, the economic growth conjecture of Triple Helix is based on endogenous knowledge and skill creation. Technology is endogenized into the system of producers, users and legislators and accumulation and investment in human capital and knowledge render socioeconomic development. This assumption provides solutions to the drawbacks of both capitalist and socialist mode of productions as well as offering sustainable development opportunities for catch-up economies.

While university-government-industry has again restarted to be less isolated in the USA, universities and industries of Latin America have recently started to gain some degree of autonomy from the strict state control. The EU case varies since the unification process had different impacts on each member state (Leydesdorff, 2000). Nonetheless, all of the cases determine the trend of Triple Helix modeled innovation networks (See Figures in Appendix D, p.234).

The model urges a movement, where the three institutional spheres will overlap, with each sometimes taking the role of the others. University, government, industry are still relatively autonomous units, but recently they have become interdependent units within the network structure of Triple Helix; they may even be called quasi-independent spheres albeit the level of interdependence and integration varies from country to country. Each institutional sphere fills its gaps from the other, even sometimes taking the role of other. For example, consortia to develop new technologies may include corporate R&D unit, academy, and government laboratories. Increasing complexity between them instigates emergence of a new layer between them as well (Etzkowitz, et al., 2000).

On the other side Kaukonen and Nieminen (1998) added to the model that even though the obscuration of institutional boundaries is considered to meet the dynamism and surprises of knowledge-based economic system. An ideal Triple Helix should be based on a balanced concept of research policy, which would confirm the different functions and relative independence of main institutional spheres. Institutional integration should be complementary, rather than eliminating the boundaries. They should undertake multiple roles and act as partner to the system, not as a sub-contractor. This broader view enables the system to be more regenerative, rather than squeezing the activities into one single model. In this balanced networking system, none of them is subordinated, and thus it can be concluded that university-government-industry networks should be organized as a means to achieve scientific-technological-innovation objectives, rather than as an end objective in itself. Therefore, in a well-balanced network, university, research institutes and industry that are acting together with governments are recognizing the need to strengthen the links between helices as well as improving the compatibility.

In conclusion, Triple Helix model states a balanced repositioning of university, government and industry relations by increasing the autonomy of industry and university from state control as well as establishing closer multilateral ties between them like a balanced strategy of both capitalist and socialist societies. However its organizing principle differs from them; while in some countries this new situation requires a reduced role for governments, and greater roles for other institutional bodies, in others where government is less active an enhanced role from government is needed. Nonetheless, despite national variances governments are focusing on the importance of universities in the creation of science-based economic development. As much as the importance of knowledge in national and regional innovation systems is increasing, universities are recognized to be incremental component of this system in cost reduction, creative invention, technology transfer (Etzkowitz, et al,. 2000).

2.3.6. New Dynamic Institutional and Functional Framework

This new setting brings opportunities for all states, currently, most of the states are endeavoring to accomplish the third path either to endure their competitiveness or to catch-up the industrialized world. As a result of evolutionary learning effects, the addition of new tasks and structures into the traditional ones state there will be new arrangements and integration of the different helices. Benner and Sandström (2000) asserted that all three spheres of

Triple Helix have merged within the new organizational field of knowledge-based economy.

They are guided by norm system stressing the importance of techno-economic renewal and market-determined success. The shared motivation is to realize an "innovative framework consisting of university spin-off firms, trilateral initiatives for knowledge-based economic development, and strategic alliances among firms (large and small, operating in different areas, and with different levels of technology), government laboratories, and academic research groups" (p.292). Moreover, Etzkowitz and Leydesdorff (2000a) mentioned there would be a gradual transformation and negotiation between different models of research performance and evaluation, which in the long-term lead to the emergence of new organizational context. These arrangements are often encouraged, but not controlled, by governments, whether through new 'rules of the game', 'direct or indirect financial assistance'.

By and large, Etzkowitz et al. (2000) explains development of a new network system resulting from the new roles and interactive relations among the helices, on account of the changes in the generation, exchange and use of knowledge. First is the internal transformation in each of the helices, such as the development of lateral ties in each of the helices itself. As a case in point, establishment of lateral ties among the firms or inauguration of an economic development mission by universities. These developments lead to the revision of existing tasks, reinterpretation of traditional roles and expansion of them for new goals. The second is the trans-institutional impact, which is the influence of one sphere upon another by bringing about a major change. Consequently overlapping institutional spheres are established where collaboration and rules for interaction are more easily understood and negotiated. Next is the interface process. A new overlay of trilateral linkages, networks and organizations among the three helices are created to stimulate network capability and cohesiveness. Centralized interface capabilities, technology transfer and university spin-off offices play leading role in the early stages of entrepreneurial activities of university and linking the three worlds. The final stage is the recursive effects of these processes. This is the formation of new trilateral organizations bringing the different institutional spheres around the common goal of fostering innovation. These cross-organizational and cross-institutional bodies are centers composed of researchers from universities, government laboratories, and companies (Leydesdorff, and Etzkowitz, 2000). In these centers, the practitioners involve the innovation process from R&D stage to commercialization; while academy is learning the marketing rules, industry learns basic research. Thus, knowledge is disseminated between them during the innovation process.

The close interaction and exchange of knowledge, learning on the job transforms the tacitness of knowledge into an organizational or networking knowledge. Moreover, risk and costs of technology transfer and stimulate the diffusion of technology are reduced. The projects are selected according to the social and economic needs. They are organized in an optimum manner with regard to capacity and capability of the partners. This provides the efficient an effective resource and personnel allocation. Consequently, the cohesive and coherent work of partners, optimum allocation of inputs, and better dissemination of knowledge render them to be more productive and generative compared to the contribution of any of them independently or in any other innovation model. Therefore, Triple Helix modeled innovation better grasps the objectives of networking theories in terms of creation synergy between the members of networks.

2.3.7. Implications of the Triple Helix

The main underlying assertion of the Triple Helix model is in the knowledge-based economy one can observe an "endless transition of innovation" (Callon, 1998) and economic growth, rather than a journey to an assumed ideal model of socialism or capitalism. Knowledge-based economy made a distinction between laissez-faire and socialist. There are neither fixed ends to development nor fixed roles for university, government, industry and others. Knowledge-based economic development is ‘self-reinforcing’; it may provide both developed and developing countries to achieve catastrophic successes. Their innovation system is supposed to be dynamic and this dynamism is generated from the integration and diversification of roles, values and cultures of each helix.

> This is why, in order to describe the process whereby the stock of knowledge and technologies is built up, the OECD’s TEP programme uses the image of a "snowball": for the snowball to roll and grow, three conditions have to be met: (a) there has to be sufficient critical mass to enter the virtuous circle of self sustained growth; (b) there have to be the resources available for maintaining the development of the snowball; (c) the snowball needs to find sufficient space to develop, i.e. the economic environment must be capable of absorbing the repercussions of science and technology and creating a system with sufficient incentives (EU EURO- Med Report 1999, www.jrc.es.projects\moco).

Previously, the various agencies worked in hierarchical systems with predefined roles or on markets, which forced roles upon them. Now they are expected to assume multiple roles and functions, not only within their own institutions, but also within these new networked and hybrid organizations. The network arrangements can be considered as an overlay that acts on a variety of institutions and organizations, which may cross institutional and national boundaries. The dynamics of interactions among the participants are complex; they can alter their positions in response to the system as well as in relation to each other’s position. The roles of university and government are not predetermined; the interaction between them will generate and sustain the specific framework of the innovation system. This reorganization is toward a mixed system of market forces and government incentives; the interaction between them is shifting from previous modes of separation or control into Triple Helix of overlapping but autonomous spheres.

Political systems have obtained a sub-systemic character. The system evolves around asymmetrical relations, the institutional actors have an equal role and level in the network, yet each of them will be positioned differently with reference to the new collective structure. Governments need to set free areas of activity as zones of recombination between academia and industry (Etzkowitz and Leydesdorff, 1996 in Etkowitz and Leydesdorff, 1997, p.162). Policies of "normative control" have been replaced by a "reflexive focus" on unintended outcomes (Etzkowitz and Leydesdorff, 1997 p.162). However while in a functionally defined political system politicians can be held liable for their actions, in a system of translations it is difficult to assign political responsibility only one actor. The system as a whole and the 'codes of communication' between them can be accountable for the success or failure of the project.

Therefore, neither the generation nor the management of innovation is any longer in the hands of a single institutional body. It has been subjected to conflict and consensus among university-government-industry and other concerned parties as well as whole society (Etzkowitz and Leydesdorff, 2001). Economic growth polices are not targeted to just to rise income levels but to create human and physical capabilities and capacities for a continuous improvement of social and economic well being.

The system opens a new window for society that generates a set of discourses transcending the discourses that previously took place within separate institutional spheres. These trans-institutional discourses soon generate a vocabulary of their own. 'New codes of communication' are developed among them. The new discourses generate visions and metaphors that can be utilized to shape new economic, political, and social initiatives. Triple Helix or the discourses are not stable since each helix brings its own cultural evolution, and thus different cultural dimensions. However, lack of stability enables the system to tackle the instabilities and risks of knowledge-based economy, where R&D

investment carries a big risk of either great fruition or abortion. Extensively, the main point in the Triple Helix network is to promote mutual commitment between stakeholders. The network should be arranged in non-zero sum game, all sides must be the winners of the game. These tensions and conflicts of interest must be addressed and solved within the interfaces of Triple Helix, in such a manner that instead of causing destruction, these tensions and conflicts will be creative and generate new perspectives for innovation (Schumpeter, 1943).

2.3.8. Importance of Triple Helix

Triple Helix brings new perspectives over the studies of Gibbons' (1994) "Mode 2" innovation Model, which is characterized by constant flow between fundamental and applied knowledge. Secondly, it is different from the "National Systems of Innovation" tradition of Lundwall (1988-92), Nelson (1993), Metcalfe (1995) and their retinue, which considers the firm as the leading factor of innovation. Thirdly, it is different from Sabato's (1975) "Triangle Model", in which the state has the privileged role. Moreover, the "Power Elite Trilateral Mode" of Mils (1958), which considered military as the third partner of the institutional setting, was outdated since the end of Cold War, and thus it was replaced by academy and with more pluralistic society of Triple Helix model.

In light of the above statements, one may say Triple Helix provides solutions to the, consistency in knowledge generation, and the problems of commercialization of basic research by introducing the idea of undertaking of new roles by actors beyond their traditional, predetermined roles. Firstly as New Growth Theory and endogenous technological change (Romer, 1990) state, that technology is endogenized into the system. Triple Helix endogenizes the knowledge production into the system of university, industry, and government. This can be seen as while firm's inputs on external technology out of the system and internal technology are decreasing, its expenditure into the system is increasing. Moreover, it also internalizes the incompatible demands and goals of stakeholders into the system, assuming to provide the system with dynamism to tackle the chaotic and unstable system.

Secondly, as knowledge society is more pluriform the Triple Helix provides the involvement of all actors into the process of innovation from basic research until commercialization. This will enable all partners to be cognizant of each phase of the innovation process, they will learn by doing and interactive partnership. This will eliminate the problem of the tacitness of the knowledge, and thus technology is transferred simultaneously on the job, the problems and costs of technology transfer are excluded from the system.

Thirdly, Triple Helix eliminates the duplication of R&D expenditure and investment independently by each of the actor. It provides efficient allocation of resources. It is the pooling of national physical and intellectual capabilities and capacities for socioeconomic welfare. This provides industry with access to ideas and concepts as well as laboratories of academia, and renders academia to commercialize these ideas. This mutual enrichment highlights the importance of elimination of 'object, physical shortages' and 'idea gap, human capital' and bridging the gap between them. It aims to strike a balance between the roles of physical and intellectual capacities in the economic development. This approach can be considered as an end to the rift between 'mainstream economists' who concerned with importance of factories, roads, and resources in progress and 'dissident economists' who consider the ability to create economic values. Additionally, closely related to its previous features, the Triple Helix stresses the importance of networking so as to create synergy among the members. The underlying point is the achievement of synergy among the members will contribute more to the economy than the contribution of independent units.

Moreover, in order to refrain from the dilemma of whether states or university or industry lose power, or gain power, instead of defining ready-made models for all states, Etzkowitz and Leydesdorff state each state will experience a unique transformation to Triple Helix. Neither within its system nor among the countries, Triple Helix is predefined path to innovation with the exact roles for the stakeholders. Instead of a standardized innovation model, states need to shape their Triple Helix model with reference to successful cases.

Furthermore, it is a market friendly model in which not only state has social and economic roles, but also industry and academia undertakes major socioeconomic roles. The application of public and private practices solved the public versus private nature of technology. The knowledge is produced and disseminated to the wider sections of society via rapid commercialization, and society becomes much more conscious of the importance of science and technology. The private interest of industry from this network is realized by seizing the benefits of introduction phase of innovation, and any subsequent repetitions may only cover lesser benefits. Triple Helix balances the public and private nature of knowledge.

The involvement of government will be solved by the equity discernment of Triple Helix for the all partners. The state may provide the necessary infrastructure, which means providing universities and industry with a better knowledge of what they need and what they can do mutually by putting them into an effective contact. (Sutz, 2000). However, during the process all participate equally, while academia may set the basic research agenda, industry mostly provide the necessary information on the market trends and customer tastes, needs, and preferences.

Nonetheless, to some extent Triple Helix emphasizes the importance of academia in the capitalization of knowledge. University is considered to be the magnet of talent, skill and knowledge and the pool of graduate students. These will magnetize industry to be close interaction with academy; still university plays a central role in this system, as it becomes the ‘basis for industry of the future

(Etzkowitz, 1999 in Branscomb et al.1999). Etzkowitz et al. (2000) also point out "establishment of universities have been a strategy for late-comers or lagging regions to build up industrial clusters and collective identity" (p.329). They suggest the design of entrepreneurial universities or reorganization of universities according to MIT or Stanford type. Thus in the medium term university reform, university-industry linkage and bottom-up incubator movement across the country may fuel the formation of innovation networks. The capacity of universities is decisive in the creation of organizational and institutional framework for innovation. Besides this, while the agenda-setting role of universities, and external evolution provide to some extent social accountability of and ethical concern over technology, the industrial and business like side of the system tests the societal acceptance of new technology.

Finally, Triple Helix does not focus only on the input-output ratios of the system, rather it emphasizes the importance of wider dissemination and acceptance of knowledge into society. Hence, this model provides the most feasible generation and dissemination of innovation into the wider sections of society as well as greater reception from the market.

2.3.9. Conclusion on the Literature Survey

This literature research presents the historical evolution of university, government and industry from institutionally defined bodies to quasi-units or hybrid organizations interacting in a network system. The organizational structure is almost blurry, since all the partners bring their own cultural and organizational values to the system. Triple Helix model is based on the integration and differentiation of these bodies, and their dynamic sub-systems. Thus as long as these bodies can evolve and generate 'new codes of communication' for within each helix itself and among the each other, then this arrangement can be institutionalized and niches for knowledge-intensive industries will be created and utilized as problem solving centers of the society and economy. These centers are not resulting from the intertwining of different institutional bodies into an ambiguous setting, but they are providing a form for different value setting for reflexive and continuous adjustment codes of communications of the helices.

Triple Helix can be considered as a microcosm of globalization process. Pertaining to the pressures of under-utilization of existing resources, and productivity paradox, and the lower application of science to social needs, the nation states found themselves to link the knowledge producers and users. National innovation systems have become complex. They are multi-institutional with various actors and their structures, and multi-functional, and multi-level working at local, regional, national levels. Thus, the whole innovation systems have become complicated, and internally integrated and dynamic just as the Triple Helix states. As globalization results in both exclusion and inclusion of some elements, Triple Helix is also functioning on this rationale.

The innovation process becomes very enigmatic game, which is comprised of many players, with multiple roles, and who may change its role, and assume different roles during the innovation process. As it involves the social and cultural evolution of helices, evolution in the Triple Helix is much more complicated than the biological evolution. Nonetheless similar to the natural selection process of biological evolution, the species that adapt to the new nature can survive. In the establishment of Triple Helix networks, there is also selection process, which is most of the cases enforced by market trends. Hence, the institutional and functional spheres who are outstanding in the market or who may adapt to the new market demands are naturally integrated into the system. However, not only the market directions, but also the internal and external dynamics should be used as a selection mechanism.

CHAPTER 3

3. RESEARCH DESIGN AND METHODS

3.1. Research Design

Chapter III presents how the data for the comparative analysis and empirical research are collected, generated and how they are analyzed. The objectives of the research are to analyze the innovation network programs and to refine concepts and conditions for the formation of innovation networks. The general research process of the thesis is a comparative analysis between Israeli Magnet Program and selected world programs designed for innovation networks. Subsequently the results of the comparative analysis and empirical research are evaluated to reach a generalization for the formation of innovation networks in Turkey.

Research Goals:

1. Identification of characteristics of triple innovation networks in general and specifically among different selected developed countries (EU, North America and Japan),
2. Identification of specific conditions for innovation networks in Israel (Magnet) in the light of the previous findings,
3. Identification of conditions for international innovation partnership,
4. Identification of lessons and recommendations for Turkey and discussion on their suitability to Turkey, are the main research themes.

Research Questions:

The research questions of the thesis (which is obtained from the literature survey) are: How innovation networks can be more beneficial for the national competitiveness and development, than conventional methods for R&D policy making such as linear model of innovation or sponsorship.

1. Is the triple innovation networking in R&D policy making around the world an undeniable trend?
2. Is it possible to the duplicate/copy the good policy practices/experiences of developed world by the late-comer countries?
3. What are the possible implications of this modeling by late-comers countries in terms of increasing welfare, equality, stability and integration at the domestic and global levels?
4. Will this research contribute to the conceptualizing, modeling and evaluation of innovation networks?

Accordingly, more specific research questions are designed such as:

1. What are the reasons for the general acceptance and application of innovation networks around the world?
2. What kind of specific conditions are conducive for innovation networks?
3. How are the results of these programs evaluated?
4. What are the main lessons for developing countries? Is it possible to identify viable policy mechanism for developing countries like Turkey?
5. What kind of structural and institutional changes need to be adapted by developing country Turkey to utilize these policies?
6. Can these policies be a backbone of the national science and technology and innovation systems in Turkey?
7. Is it possible for Turkey to integrate world science and technology and innovation system due to these adaptations?

Finally, the concept of 'synergy creation and achievement of synergy among the participants for the effective network' are sensitized to clarify and to delimit the case studies. Regarding to these research questions and goals a cross-country research method is chosen for the collection of data on different national applications for innovation networks.

The data for the countries are gathered from Country Reports prepared by European Trend Chart on Innovation, OECD Reports and statistics and national reports on innovation systems. Thirteen different national programs are examined in a comparative analysis. The methodology for the selection of these programs is based on the general national R&D expenditures and personnel. More specifically the level and capacity of countries for industry-science cooperation are taken into account for the selection of the countries. Accordingly, the countries are divided into two groups of relatively larger and smaller countries. Among these countries, the programs that demonstrate a good policy practicing in triple innovation networks are chosen to be analyzed.[3]

The literature survey[4] identifies the following presumptions to compare the different national innovation networking measures:

- The reasons goals and objectives,
- The administrative structures: role of governments, and participants
- The financial systems,
- Eligibility criteria for participation and projects,
- Results and implications employed to compare the programs.

The comparative analysis aims to determine the similarities and differences between the national innovation networking measures. Second, these cases aim to discern patterns and formulate principles that might guide innovation policy making in the developing countries. The comparative study states the importance

[3]See the detailed methodology for selecting the countries and the programs in Chapter III.

of 'the identification of the national objectives and priorities, achievement of the conditions for innovation networking, and creation of synergy among the members. Moreover, it underlines formation of innovation partnership between the countries and institutions with similar tendencies and organizational structures is more promising than the between different countries and institutions. Finally, the cross-country cases lead to the observation that impacts of innovation networks are widely evaluated through the better optimization of R&D inputs and better achievements in R&D outputs rather than calculating the net financial outputs. The data is analyzed and evaluated to reach empirical generalizations and formulated as findings for the empirical research on Magnet. The information base on Magnet is collected through the fieldwork in the country. At the academic level, interviews are conducted with the academic coordinators of the consortiums. At the industrial level interviews are held with project leaders. Additionally data from Israel Central Bureau of Statistics are used. Besides these data from most recent sources like OECD figures and statistics, European Trend Chart of Innovation, and Eurostat are also used.

3.2. Survey Design: Empirical Investigation

A field survey is done on Magnet to materialize the observations of the cross-country analysis and to underline the importance of these factors for innovation networks. Regarding the results of the comparative analysis multiple-choice survey/questionnaire is constructed for the members of the board of each consortium (see Appendix E. p. 230). Nine consortia out of twenty-two different consortia under the Magnet Program are selected.

The questions are designed to find out the functioning, reasons and impacts of Magnet Program on Israel economy through the observation, belief and satisfaction of the participants. Particularly, the empirical research aims to uncover the relevance of the Triple Helix Model to the Magnet Program's:

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[4] See theoretical framework described in Chapter II.

- Organizational/administrative structure;
- Motivations and reasons for the initiation;
- Motivations and reasons for participation;
- The role of board of consortia
- Target groups of the Magnet;
- Targeted \ or Preferable sectors, and types of industrial companies;
- Eligibility criterion of projects, appointed institutional body reviewing the project options;
- Institutional framework for the decision-making process top-down or bottom-up
- Impacts of Magnet on the institutional settings of participants;
- Achievement of the qualifying factors of a standard network mechanism by Magnet.

For the evaluation of the impacts and contribution of Magnet to Israel, these criterion are utilized

- Change in the economic indicators, such as the amount of employment, engineers, R&D personnel; exports and net profits;
- Decrease in the R&D innovation inputs, such as R&D equipment costs, R&D personnel costs, time-span for R&D;
- Improvements in the R&D innovation outputs/outcomes, such as human capital, innovation capability, innovation capacity, variety-quality of products and services, and number of patents;
- Importance of Magnet program to the participants;
- Satisfaction of participants from Magnet;

In order to get and to evaluate the information easier the questions are designed as close-ended questions with check-lists and rating scales that ask respondents to make comparisons in the form of orders. Furthermore to ensure that comparative rating scales provide the accurate information, respondents are specifically chosen from the active participants ‘Consortium Board Members’, who are in a position to make comparison and have experience in the progress of consortium. Between July 2002 and September 2002, around 100 self-administered questionnaires were distributed by post, e-mails, and facsimile or directly and they were administered by the coordinators for instructing and follow-up. 40 responses have been received at the end of the survey duration of three months.

3.3. Analyzing Data from Surveys

In the analysis part behaviors, beliefs and observations of these specific groups are identified, reported and interpreted. First the analysis of the responses is classified into two main groups of industrial members and non-industrial members (academics or government employees and coordinators). A second classification is done based on how many responses are obtained from different consortia. Accordingly, ‘tallies and frequency counts techniques’ are used to compute how many of the respondents and responses are appropriate into a specific group or category. The tallying and frequencies are in the forms of numbers and percentages, additionally they are grouped according to the responses.

Second a ‘descriptive statistical analysis’ is employed to measure the proportions (percentages), central tendencies (the mean, median and mode) and the variation in the behaviors, preferences and rationale of the respondents. The descriptive statistical analysis reveals the average importance or satisfaction ratings assigned by respondents to the concerned factors such as importance of factors for the creation of synergy in the consortia. Moreover, computation of the frequency of scores reveals the prevailing view for that factor. On the other hand, variations among the responses are also calculated. Though the variation between the responses can be considered as a drawback to make generalizations, it can be an asset as to reflect the variety of reasons and implications of innovation networks.

Third, the correlation between specific questions one to show relationship such as between the reasons to participate and overall satisfaction or re-participation. Moreover, the relationship between the difference in the company's outputs and the ratings for the possibility of achieving it without Magnet is correlated. A fourth method is to test differences between industrial and non-industrial participants.

The observation on the Magnet Program specifically presents the success of triple innovation networks in Israel. However, combination of these data with theoretical structure on innovation networks and cross-country analysis enables the research to identify and estimate the structural parameters for initiating new innovation networks at national and international levels. Finally, these findings are formulated for an innovation framework for Turkey.

3.4. Potential Implications

This research contribute to the existing literature on innovation networks and Triple Helix model by examining the cross-country trends for triple innovation networks moreover it takes it further by stating the condition for supra-national innovation networks. This will enable policy-makers of a developing country to map their systems. Second, the understanding of recursive innovation modeling and partnership contribute to the supra-national welfare, peace and stability as well. It fits to the eliminating boundaries and creating bridges argument of innovation networks.

CHAPTER 4

4. AN OVERVIEW ON THE ISRAELI SCIENCE AND TECHNOLOGY SYSTEM

4.1. Israel and Domestic Facts

4.1.1. The Framework to Analyze Country Cases

Triple Helix brings a more accurate explanation to analyze the innovation systems of 21st century and synergy creation. It clarifies how different institutional spheres work in such an optimum manner that the network of these bodies contributes more to the industrial and economic progress than the sum of these bodies. In the light of these theoretical arguments, this chapter examines the Israeli case to elucidate the specific conditions that make the establishment of a successful science, technology and innovation system in Israel. Subsequent to this, it presents a comparative analysis between the Israeli Magnet Program and twelve selected world programs in order to ascertain the determinants of innovation networks.

4.1.2. The Case of Israel

"Mediterranean Dragon"

Today Israel is one of the most technologically developed countries in the world. Israel high-tech industry was born de facto before the State of Israel, in 1948 on the ground of its deep-rooted scientific research culture (Frenkel, et al. 2000). The government's strategy rests on two pillars: decentralization to promote initiative and co-ordination to promote efficiency. Central planning, co-ordination and control of research are somewhat limited, and government-sponsored science is highly decentralized (EU MNC Report 1997). An important feature for co-ordination within Israel is the fact that Israel is a compact country with a relatively small population. “The close-knit nature of the scientific community greatly facilitates good liaison and co-ordination” (EU MNC Report, 1997, p.1). R&D in Israel is performed primarily in the universities, public research institutes, and industry. Significant research is also carried out in hospitals and by a number of public service utilities. Israel has five major autonomous institutions of higher learning such as Technion-Israel Institute of Technology, Weizmann Institute of Science, and Universities in Jerusalem, Haifa, Be’er Shava, Tel Aviv along with two nuclear research plants. All institutions have special units for applied research and for commercializing university research results. Moreover there are many public research institutes, medical centers and research centers at universities. Additionally there is a close cooperation between industrial parks and universities such as Kiryat Weizmann Industrial Park and Weizmann Institute in Rehovot; Jerusalem’s Har Hotzim and Malkah Technological Parks and Hebrew University; the MATAM High-Tech Park and Technion and Atidim High-Tech and Tel Aviv University. On the other side, the branch of Israel Defense Forces ‘Science Corps’ provided the technological needs of army and the nation as well.

Israel has 2,000 high-tech companies and more than 3,000 high-tech start-ups. This is the second highest concentration in the world in real terms after California (Nordfors and Berger 2000). There are more than 120 companies traded on the US stock exchange and more than 20 companies traded on European exchanges.

Secondly, Israel has a highly talented and highly educated human capital. Education constitutes the highest share in the national budget, even more than defense. Israel civilian labor force is 2 million; 25 per cent of it is working in professional, technical, scientific and academic positions. Skilled laborers make another 24 per cent they hold academic degrees. 38 per cent of the labor force has more than 13 years of education and over 17 per cent have 16 years or more years of education, more than 30 per cent of university student study in the fields of high-industrial R&D potential. 20% of Israel's work force are university graduates, which ranks it 2nd after the US and higher than Canada (17%), Britain (12%), and Italy (8%) (Cohen, 1999; MOIT, 2002). It has the largest percentage of engineers with 1,35% compared to 0,85% in the US and with 28,000 medical doctors per capita it has been ranked first in the world. Israel has a very high ratio of scientists and engineers (140 per 10,000 workers), compared to the USA the number is 80 and Germany is 60 scientist and engineers per 10,000 workers (Nordfors and Berger, 2000). Moreover, the recent immigration flow from the ex-Soviet Union increased the scientific and technological capacity of the country. 40% of immigrants hold academic degrees (especially those from ex-Soviet Union).

According to Table 1, the professionals who have or will have academic degree, make up almost 10 per cent of the total employed persons in manufacturing establishments engaged in R&D, while the practical engineers and technicians make up 4.4 percent. This fact indicates that the Israeli manufacturing is highly based on R&D activities.

Table 1. Scientist and Engineers in R&D in the Israeli Manufacturing Industry

Year	Total Employed Persons in Manufacturing Establishments (in thousands)	Professionals engaged in R&D (in numbers)	Practical engineers and technicians engaged in R&D (numbers)
1990	93.7	5197 (5.5)	3104 (3.3)
1991	89.9	6055 (6.7)	3345 (3.7)
1992	83.8	6398 (7.6)	3158 (3.8)
1993	81.5	6437 (7.9)	3434 (4.2)
1994	81.2	7199 (8.9)	3223 (4.0)
1995	78.4	6791 (8.7)	3383 (4.3)
1996	81.2	**7919 (9.8)**	3558 (4.4)

Source: Central Bureau of Statistics (1998) in Mani, S. p.39.

On top of having these centers of excellence and a highly skilled human force, Israel achieved the creation of an efficient network mechanism among these people and institutions as well. Indeed Israel is a networked society, even before the establishment of institutions Israeli people operate through personnel networks, they gain each other's commitment and trust and then work together straightforwardly. Indeed there is a close cooperation and crossover between Israeli military-civilian and academic settings either under institutional frameworks like Talpiot[5] program, which gives military and academic education, or the as the relations between some of the military spin-offs and technological incubator programs of the OCS or any kind of military-industry individual relations. Undoubtedly, the most important factor is the mobility of people in technology transfer and interactive learning.

Nordfors and Berger (2000) also underlined the entrepreneurship and risk taking culture as important factors for the success, creativity, flexibility and survival of the Israeli economy. There is a culture of promptness and small organizations in which an individual can take personal initiative without waiting for the permission of high bureaucracies. Therefore long-range planning, complex settings are considered to lower trust and efficiency of the system in Israel.

4.1.3. Israeli Economic Background

Israel is a technologically advanced country with substantial government participation. As a country of six and half a million (with the recent immigration flow of 1990s), having limited resources and is encircled by some hostile neighbors Israel needs to create synergy between its people and institutions in order to utilize its capacity at the utmost level to be competitive at the global markets. It has to rely on its people to create added value, thus Israeli scientists always need to devise and develop new and innovative solutions to the challenges that the nation faces. History and geography urged Israel to find quick responses,

[5] Talpiot program has been established in 1979 to increase the R&D capacity of the military.

shorten the development process cycle, and turn them into commercial products. Despite these impediments, Israel experienced rapid economic growth and industrial expansion between the late 1950s and early 1970s and 1990s.

There are important milestones in Israeli economic development. Until 1967, Israel was relying on foreign support for the acquisition of new technology. However, as a result of the 1967 Six-Day War, France imposed an embargo on the export of military technology to Israel. Although this seemed to be an un ominous situation, it led Israel to launch a strategic program to reduce the dependency on foreign technology by establishing its own R&D capacity for military industry, by products of this policy were also experienced in civilian industry. (JIM, 1987; Sokolov, Verdoner, 1997, Frenkel, et al., 2000). Though Ireland, Portugal, Greece, Singapore and Taiwan have also established R&D programs, Israel stands alone in basing both its civilian an and military R&D on indigenously owned companies through the introduction of Law of Encouraging Capital Investment, establishment of science parks and provision of research grants (JIM, 1987, Frenkel et al., 2000).

In the early 1970s, Israel experienced a series of shocks, Yom Kippur War (1973); oil crisis; recession in advanced countries; slowing down of population growth and immigration rates. These challenged Israel economic and social progress. It has faced a constant decrease in its capacity to grow and to increase the living standards. The economic stagnation of 70s slowed down the pace of change in Israel's economy. Consequently, it suffered from severe economic crisis and uncontrolled high inflation. The 'Law of Encouraging Capital Investment' lost its effectiveness (Razin, 2002). While between 1960- 73 GDP growth per person was 10%, in 1973-86 it was only 9% and since 1980s it grew only 0.3% per year. Since mid of the 80s Israel experienced an increase in living standards due to the foreign borrowing (JIM, 1987, Roper and Frenkel 2000). Although Israel had a reasonable amount of export first of all most of Israel's export revenues went to pay foreign debt, and prevented Israel to import raw materials and industrial products for further production. Second, other small countries with higher income levels exported two to five times more than Israel in 1985. Additionally at the global level, Israel faced a more dynamic and diversified markets, intensification of competition, rapid technological changes, reorganization of industries in more flexible ways, and the agglomeration of economies.

Despite these detrimental effects on the Israeli economy, it experienced several internal and external enhancements. The end of the Cold-War, Middle East Peace Process, reduction of military industries and closure of the ‘Lavi’ project of the Israeli Defense Forces freed the a great number of engineers to leave the military industry for the civilian sector and who worked as highly skilled industrial engineers (Frenkel et al., 2000). Secondly, in the early 1990s though some of the European Countries also received some immigration flows from the ex-Soviet Union Bloc countries, none of them had a massive immigration of highly skilled workers from the former Soviet Union as much as Israel. Both the Jewish population and veteran ex-military engineers brought an extensive amount of intellectual and technological capacity to the Israel industry.

Additionally, since 1994, there has been a great increase in the amount of foreign direct investment in Israel (Frenkel et al., 2000). Thus, in several studies the importance of skilled personnel capacity of Israel and the recent flow of well-trained new immigrants from Western Europe and ex-Soviet Union has been considered as the main reasons (Sokolov & Verdoner, 1997; Cohen 1999; Mani, 1999, Razin, E., 2002).

Table 2. Share of Scientist in Total Immigration to Israel, 1989-1998

Year	SS	TI	SRCA
1989	1.16	24050	280
1990	1.13	199516	2250
1991	3.02	176100	5310
1992	9.90	77057	7630
1993	11.98	76805	9200
1994	12.70	79844	10140
1995	14.36	76361	10965
1996	16.50	70919	11700
1997	18.39	67990	12500
1998	23.42	56593	13275

TI: Total Immigration; SRCA: Scientist Registered at the Center of Absorption, SS: Share of Scientist **Source:** Ministry of Immigration Absorption, www.moia.gov.il/english/statistika/statist/table/ in Mani, S. p. 40, 2000

Besides having this talented human capital flow, the ability of Israel in absorbing almost 750,000 immigrants, directing this talented human capital into the correct institutional settings and rendering the interaction among these institutions is the main fuel behind the high-tech boom in Israel. Indeed, according to World Competitive Handbook Statistics, Israel comes second after Finland in Company-Company Technical Cooperation and third after Finland and Singapore in University-Company Cooperation (in Dodgson 1999, see the list in the next section).

Nonetheless, even if Israel had pursued a policy of higher production Israel's domestic market is too small to achieve an efficient production scale in a wide variety of industries (JIM, 1987, Sokolov & Verdoner, , 1997). Moreover, it had the risks of stagnation and inflation; thus, Israel launched the policy of increasing exports of goods with high value added. As high value added products are the results of high technologies and innovation, there has been a great demand for the establishment of high-tech industries. The necessity and motivation for the production of high-tech is based on to achieve higher export rates, and generate more jobs. Moreover in addition to appropriateness of high-tech industries to environmental concerns, High-Tech industries are less vulnerable to transportation costs, since the price weight ratio of these products are relatively high, and this provides widespread diffusion of production (Shefer and Modena, 2001). Finally, this contributes to the establishment of an independent R&D capacity.

Though establishing a high-tech and innovation base for higher export rates seems promising a prosperous future, it requires appropriate actions both from government, industry and academic sector. Hence the Israeli state has instituted a comprehensive method to innovation support that is formed according to its local needs, but employing universally applicable methods. Israel system benefited from the world experiences such as:

"Sweden, France and Japan in terms of risk sharing in new products and markets;
Denmark and Germany for sponsorship in marketing;
Canada, France and Japan for restructuring import substituters for export;
Germany, the USA, and the UK to assist start-up firms;
Japan, France, Germany and Europe to encourage R&D collaboration;
Sweden and Japan to minimize the bureaucracy associated with controls" (JIM, 1987, p.12).

The Israeli system is a well-balanced blend of these policies as well as customization according to the internal dynamics. The Israeli domestic structure was repressed by the wars of 1948, 1956, 1967, 1973 and 1982; however, none of the competitor countries has suffered such big problems. Additionally, Israel used to have less stable macroeconomic environment than the competitors did. These compelled Israel to take more serious measures than those countries to overcome the problems of the hyperinflation, business competition, exchange rate shifts, and high defense burden.

The Israeli industrial support system is designed not only to alleviate the side effects of the 1970s-80s economic stagnation, ongoing domestic problems, and global challenges, but also to utilize the internal opportunities. Thus, Israeli support system is formulated to provide the innovation system with financial support, managerial consultancy, and guidance to help to tackle the dynamism of global markets. The Israeli National Innovation System has brought high prosperity for the nation because of its responsiveness to time and efficient management of public needs and entrepreneurial goals. Though Israeli System is composed of several institutional bodies and programs this study compares the Magnet Program with other models as a typical experience to Triple Helix Model.

4.1.4. Government Policies for Industrial R&D

The Israeli government policies for domestic technology development can be divided into 3 main phases. In 1968, Prof. Kachalsky, initiated the creation of the Office of the Chief Scientist (OCS) at the Ministry of Industry and Trade; in order to support private R&D projects (Trajtenberg, 2000, Mani, 2001). In 1969-1987 industrial R&D expenditures grew at 14% per year, and high-tech sector grew from $422 million in 1969 to $3,316 million in 1987 (Toren, 1990 in Trajtenberg, 2000).

The second impetus is the enactment of the ‘Law for the Encouragement of Industrial R&D in 1984-1985’, and which has been revised several times since then. The law is designed to develop science-based, export-oriented industries, promote employment and improve the balance of payments. This legislation is designed for the full utilization of national resources, and for the enhancement of the level of human capital (Trajtenberg, 2000).

The global changes of high-tech sector in the last decade and the budgetary constraints of the late 1990s require a revision of the 1985 Law. Thus in 1990s government introduced a comprehensive support system, which mainly focused on 'matchmaking support, investment support and consultative support'. Matchmaking program aims to bring companies together; investment support is the direct or indirect financial support for the development and marketing of innovations. Consultative support provides free management, legal, and financial advice to industries. Thus, any kind of company receives funds for the development of innovative, export-targeted products. (Sokolov, M., Verdoner, E.M., 1997, Trajtenberg, M. 2000).

On the other hand, Teubal (1999) divided the Israeli industrial R&D support system into 2 phases: The R&D penetration phase till 1990s, and the Silicon Valley Phase of 1990s onwards. In the former phase, the goal was learning how to innovate. In the second phase, it went well beyond this target, and diversified and expanded into new areas.

4.1.5. Governmental Priorities and the OCS Support Programs[6]

This part presents the Israeli R&D programs supported by government. Israel has a wide range of R&D support programs; however, all of them are organized and operated under the umbrella of the Office of Chief Scientist (OCS). This provides the science and technology and R&D system with efficiency, effectiveness and prevents any cross spending, or conflicting purposes.

4.1.5.1. Domestic Programs

1. Pre-seed Program

a) Technological Incubators:

[6] The data on OCS programs are collected directly from the web page of Ministry of Trade and Industry, Israel.

Provides a framework and support for nascent companies to develop their innovative technological ideas and form new business ventures that can attract private investors.

The program is open to private investors to become owners of the incubators and to invest in the nascent companies at an earlier stage, thus enabling a greater return on investment.
Grants are up to 85% of the approved expenses.
Budget: approximately $30 Million/yr.

b) TNUFA:
Designed to encourage and support an individual entrepreneur in his initial efforts to build a prototype, register a patent, design a business plan etc.
Grants are up to 85% of the approved expenses.

c) NOFFAR:
Designed to support applied academic research in biotechnology in order to promote the transfer of the technology to industry. This can be also considered under the umbrella of consortia program just focusing on biotechnology area.
Grants are given up to 90% of the approved expenses.
No royalty payments.

2.Competitive R&D

a) R&D Fund:
Supports industrial competitive R&D projects. Grants are between 20%-50% of the R&D budget, depending on the committee's decision. Royalty payment is 3%-5% of future product sales.
Budget: approximately $300 Million/year.
Supports over 1000 projects each year from more than 500 companies.

3.Generic R&D

a) Generic R&D:

Encourages companies that invest widely in R&D to invest a larger portion of it in Generic Long term R&D.

Grants are up to 50% of the approved budget.

No royalty payments.

b) Magnet:

Supports the formation of consortia comprised of industrial firms and academic institutions in order to jointly develop generic, pre competitive technologies.

Grants are up to 66% of the approved budget

No royalty payments.

Budget: approximately $60-$80 M/yr.

c) Mini-Magnet (Magneton):

Promotes transfer of technology from academia to industry via mutual cooperation between one company and one academic research program.

Grants are up to 66% of the approved budget.

No royalty payments.

4.1.5.2. International Programs

Since Israel is small and has been isolated geographically, international collaboration is an important element in its policy. The Israeli government participated in several bi-national and international programs. There is a "free market" approach to international scientific co-operation aided by Israel’s approach to international travel. Israel’s international scientific relations are among the most dynamic and substantive features of its scientific activity, and it maintains international scientific relations with non-governmental scientific organizations (EU MNC Report, 1997). Israel also collaborates extensively with the EU in its various programs. This gives domestic firms an opportunity to access international sources as well. BIRD (the USA), CIIRDF (Canada), SIIRD (Singapore), BRITECH (UK), KORIL (Korea) and EUREKA (EU) are the main programs for this objectives.

Israel aimed to be the country of high-tech innovators and exporters, but in 1990s, it has been observed that Israeli industry was too fragmented and the companies were too small to handle the rising costs of R&D competition (Trajtenberg, 2000). On the other hand, though Israel has highly qualified universities and researchers, they were working apart from the industrial and market needs. The capacity of the Israeli universities and researchers for generating economic wealth was underutilized. To remedy such failures, developed world and newly industrializing countries are pursuing the policy of formation networks between industry and academia. Under these circumstances, the Office of Chief Scientists initiated the Magnet Program to support the formation of consortia between industry and academia.

The Magnet is the main program of Israel government for the promotion of clustering and cooperation of university, industry, and government for innovation. Moreover, as it is classified under the policy programs for the gearing of research to innovation and intensified co-operation between research, universities and companies, it will be the relevant program for the comparative analysis with world trends (ETCI 2000 and CORDIS, 2000).

4.2. Israel and World Trends

4.2.1. Country Specific Innovation Network Programs

This section presents micro level observations on national innovation systems regarding the programs on university, industry and government cooperation. It deliberately stayed away from detailed country descriptions to lift analysis from country level to cross-country trends towards Triple Helix. It focuses on the programs aim to strengthen the university-industry-government cooperation under the pressures of globalization.

Albeit the process of globalization has different impacts on nation states, they are all endeavoring to tackle the systemic alteration to knowledge-based economy. Until the 1990s, the government policies for innovation varied and there were different policy tools to be applied depending on the national needs. Public procurement and supplies, scientific-technical and educational supports, taxation, and political-legal regulations used to be government policy tools (Rotwell and Zegweld, 1990). The government intervention in science and technology policies has been used to be justified on the basis of correction the "market failure" and to promote technological development and innovation. However, the transition to information society and knowledge-based economy require new roles for governments as to eliminate the systemic failures and barriers for knowledge creation (OECD, 1999, p.21). Consequently general international innovation generation and management culture and philosophy have emerged despite slight differences. This chapter describes the different kinds of innovation networking measures that different countries introduced for the management of the new economic mode and in the light of these descriptions it presents a comparative analysis of these programs to highlight the determinants of innovation networks at the national levels. Even though these specific programs can be criticized as not to be the whole systems, their organizational philosophies become the backbones of the whole systems. Accordingly, the philosophies behind these programs can be driving and organizational tool for innovation framework for both catching-up countries and international cooperation.

Primarily, the general definitions over R&D and actors are presented to clarify the matter beyond the discussions in the literature and to reach supra-national acceptance[7]. Frascati Manual of OECD (1980) defined R&D 'as research and experimental development (R&D) comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge including knowledge of man, culture and society and the use of knowledge to device new applications'. Basic criterion for distinguishing R&D from related activities is the presence in R&D of an appreciable element of novelty. R&D is a term covering three activities: basic research, applied research and experimental development. Moreover, as identified by the Statistical Office of UNESCO, R&D activities are part of a wide range of activities that include Science and Technology Activities (STA) related to the production, development, dissemination and application of scientific and technical knowledge. In addition to R&D activities, the STA includes scientific and technical education and training activities, as well as scientific and technical services.

Furthermore, regarding the Francasti Manual of OECD, the General/Gross Expenditure on Research and Development (GERD), means expenditure on R&D in the country. Expenditure on R&D funded from abroad was included, whereas payments made abroad for R&D were not. In the presentation of the national expenditure on R&D, defense R&D is excluded. Defense R&D includes all R&D activities for military purposes, irrespective of their content or secondary civilian applications. Finally, the units operating and financing R&D are classified into four sectors according to OECD definitions as; Government, Business, Higher Education and Research centers. The definition and classification of these sectors are also accepted by the OECD states and Israel as well. Hence regarding the consensus of countries over these definitions makes the comparative research more feasible and reliable.

On the other hand OECD 1999 Report on the Managing the National Innovation Systems underlined, there are mainly two sets of source of diversity between countries in STA. The first set is the country size and level of development. Large-developed countries the USA, Germany, UK have diversified R&D

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[7] For Further information see Francasti Manual of OECD resulted from Francasti Conference, and

activities and they have advanced customers and opportunities to get the economies of scale. On the other hand smaller developed countries e.g. Sweden, Finland, Israel need to internationalize their R&D activities, to reap the profits of international technology trade. The second set of diversity relates first to the respective roles of the main actors such as firms, public and private research organizations, government and governmental bodies in innovation processes and second to the forms, quality and intensity of interactions among these actors. On the other hand "the financial system, corporate governance, legal and regulatory frameworks, the level of education and skills, the degree of personnel mobility, labor relations management practices" of each country determines the variable roles of actors (OECD, 1999, p.22). Thus, the dynamics of R&D regime of a country is a complex process of its macroeconomic regulatory framework, industrial clusters, education and training system, science system, firms and communication infrastructure and networking capabilities between these settings.

OECD 1999 Report tried to classify countries regarding to their R&D expenditures, though it seems a bit ignorant of those factors mentioned above it provides the initial classification for the countries. According to this report: (i) The government intramural R&D expenditure (GOVERD) accounts for a higher share of total R&D expenditure in catch-up countries (Greece, Mexico, Poland, Turkey, Portugal). (ii) In developed countries (Belgium, Ireland, Japan, Sweden, United States) business sector R&D expenditure amounts to most of the R&D funding (BERD). (See Tables 3-4). On the other hand the share of R&D expenditure in the higher education sector (HERD) financed by government is declining, while the contribution of business sector is increasing.

A further aspect is governments tend to away from Cold-War military considerations, and inclined towards new societal needs of ageing populations, environment, and competitiveness. Still military considerations still play

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www.cbs.gov.il\eng\intro.

important roles in some countries (France, Sweden, United Kingdom, and the United States). OECD 1999 Report plainly states what Triple Helix Model suggested as each country could pave its way to innovation networks (OECD, 1999). Thus, these two sets of divergence have incited different scientific, technological policies, patterns of export, productivity growth and specialization areas in each country[8].

As OECD 1999 report assures each state has experienced its unique transformation to information age and knowledge-based economy, even if they tackle similar social and economic changes they have still a tendency to pursue different policy trajectories shaped by past and present patterns. Consequently, while there is a widespread recognition that the relationship between the various actors of the innovation system and the transfer of knowledge between them is extremely important for maintaining or improving national competitiveness, the specific measures introduced to achieve this goal vary according to existing national capabilities, thus innovation policies cannot be simply adopted from other countries. Nonetheless there is still the possibility of mutual learning, acquiring complementary policies and even 'recursive modeling' for the latecomers (OECD, 1999; TEKES, 2001).

However, it must be kept in mind that formulation or even accomplishment of these new policies do not necessarily lead to the same success stories in all of the states, since none of the participants are "simple algorithms to optimize production functions" but they are learning organizations whose efficiency depends on diverse and country-specific circumstances (OECD Report, 1999, p.12). On that account in order to identify the reasons behind the national differences and similarities, this chapter focuses on several country experiences and presents a comparative analysis of Israel Magnet Program and selected World Programs. This comparative analysis first illustrates what Israel's

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[8]For further clarification, see OECD statistics on specialization patterns in patenting activity in

competitors as well as collaborators are doing different and similar to Israel in terms of science-industry cooperation, and thus proposes some complementary points for Israel. In light of these comparative studies, the empirical study on Magnet is assessed. Furthermore, the comparative analysis of successful practices, the deduction of the indicators of innovation networks help the policy-makers of a catching up country Turkey to map out its own national innovation system based on university industry cooperation. Finally, this cross-country analysis and the recursive modeling of the typology for Turkey aims to reinforce the recognition of the Triple Helix modeled innovation systems as paragon to be employed by both developed and developing countries not only for cooperation at the domestic level but also at the international arena.

4.2.2. Background for Selection of the Countries and the Programs

In order to state the basis of the selection of the countries and their programs for the comparison between Israel, the indisputable facts of R&D inputs of the countries are examined as the initial classification method. The first selection item should be the Gross Domestic Expenditure (GDP) on Civilian R&D "GERD", which means the percentage of the GDP allocated for R&D. According to Table 3, Israel with its 3.6 % GERD, has the highest share at the world level, and comes before Sweden 3.5%, Finland 3.1%, Japan 3% which are the outstanding countries of innovation. Israeli GERD is twice as much as the EU average of 1.82, and much higher than G7 average of 2.44% and OECD average of 2.21%. In most of the countries such as the United States of America, Germany, Denmark, Holland, France and Korea the GERD is lower something between 2% and 2.5%, and in most of the developing countries such as Turkey it is between 0.5% and 1.9% of the GDP.

The second item is in terms of the financing sectors of GERD. Israel with 30.4% of GOVERD is lower than the median of OECD countries with 31.1%. It is also lower than the EU median which is 36.9%. When Table 6 is examined in details

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selected areas, export specialization by manufacturing industry, 1999.

it can be stated the higher percentages of the GOVERD is an indication of developing country trends of such as in Greece, Portugal, Turkey with a share of between 50 % to 68.3%, since they are still in the need of establishing their science and technology infrastructure and their industries are in lower technological levels to support R&D at higher levels.

The total Business R&D expenditure of states, (BERD), is higher in Israel. The Israeli business financing of R&D is 60.4 % , which is more than the OECD countries median, which is 52.6%. However, in Germany, Finland, Belgium, the US, Switzerland, Sweden, Ireland, Japan and Korea the percentage of BERD is higher than in Israel- between 63.6% and 72.5%. The higher education sector expenditure on R&D, (HERD), in Israel, it is 5.1%, and more than the OECD median, which is around 3.0%. A developed country trend in the HERD is while the government financing is decreasing, the business financing of higher education is increasing (OECD, 1999 Report).

Table 3. The Allocation of Civilian GERD by Financing Sectors

Country	GERD $	% of GDP on R&D	% of GOVERD	% of BERD
Israel	………	3.6	30.40	60.40
Australia	N.A	1.4	47.80	45.00
Belgium	5,025.4	1.8	24.90	69.40
Canada	14,727.0	1.6	31.20	49.30
Denmark	2,968.9	2.0	36.10	53.40
Finland	3,752.0	3.1	30.00	63.90
France	29,239.9	2.0	40.20	50.30
Germany	47,573.6	2.3	33.80	63.60
Greece	1,084.3	0.5	53.50	21.60
Iceland	170.0	1.9	51.20	41.70
Ireland	1,083.8*	1.4	22.20	69.10
Italy	13,830.0	1.0	51.10	43.90
Japan	95,084.0	3.0	19.30	72.50
Korea	18,543.0	2.4	22.90	72.50
Netherlands	8,394.8	2.0	37.90	48.60
New Zealand	752.1	1.1	52.30	30.50
Norway	2,140.2	1.6	42.90	49.40
Portugal	1,268.7	0.6	68.30	21.20
Spain	6,375.1	0.9	38.70	49.80
Sweden	7,755.5	3.5	25.60	68.80
Switzerland**	4,867.6	2.7	26.90	67.50
Turkey	2,635.9	0.49	53.70	41.80
U.S.	197,830.0	2.3	29.20	66.80
UK	22,467.0	1.6	37560	47.30
EU-15	157,641.0	1.82*	36.9	54.1

As a million of 1999 PPP $ 1999 GERD: gross domestic expenditure on R&D, GOVERD: Government Intramural expenditure on R&D as % of GERD, BERD: Business enterprise expenditure on R&D, ONR: other national resources expenditure on R&D.

*1997 figures, ** 1996 Figures (In this list the percentage of GERD financed by abroad are not included.

Source: CBS Pub.1149, National Expenditure On Civilian R&D 1989-99

Source:www.oecdnt.ingenta.com/oecd/eng/wdsview/dispview.asp.

According to those arguments and Table 3, Israel is a country with the highest GERD, higher BERD and lower GOVERD. Thus, it fits the group of developed countries which have higher gross R&D expenditure GERD, higher BERD, and relatively lower GOVERD. Though Israel has outstanding shares relative to most of the OECD countries, it is not a big share in absolute terms. Table 4 displays that Israel with a GDP per capita 17,000 is far much less than the USA 33,900, Finland 22,800, Sweden, 23,000, Japan 24,500 and some more OECD countries; it is also lower than the OECD median which is approximately 25,000. Nonetheless, with its 3.6 per cent of GDP allocation Israel surpasses most of these higher GDP countries such as Norway, Denmark, Canada.

Table 4. GDP per capita in US$, using PPPs, 1999 and Population

Country	GDP Per Capita	GERD Per Capita	Population**
Luxembourg	39.300	N.A.	448,469
US	33.900	775.0	280,562,489
Norway	27.600	464.0	4,525,116
Switzerland	27.500	676.0	7,301,999
Denmark	26.300	521.0	5,368,854
Canada	25.900	411.0	31,902,268
Ireland	25.200	296.0	3,883,159
Netherlands	25.100	462.0	16,067,754
Japan	24.500	723.0	126,974,628
Australia	24.400	339.0	19,546,792
Belgium	24.300	411.0	10,274,595
Germany	23.600	544.0	83,251,851
Sweden	23.000	732.0	8,876,744
Finland	22.800	701.0	5,183,545
UK	22.300	346.0	59,778,002
France	21.900	424.0	59,756,983
Italy	21.800	226.0	57,715,625
Spain	18.100	160.0	40,077,100
New Zealand	18.000	194.0	3,908,037
Israel***	17.000	673.0	6,029,529
Portugal	16.500	92.0	10,084,245
Korea	15.900	344.0	22,224,195
Greece	14.800	68.0	10,645,343
Czech Rep.	13.100	158.0	10,256,760
Mexico	8.100	27.0*	103,400,165
Poland	8.100	57.0*	37,625,478
Turkey	6.300	32.0*	67,673,928

Source: www.oecdnt.ingenta.com/oecd/eng/wdsview/dispview.asp (1997 Data).
****Source:** www.census.government.cgi-bin/ipc/idbrank.pl
*****Source**: CBS Pub.1149, National Expenditure On Civilian R&D 1989-99

As the main aim of the comparative study is to figure out the achievement of industry-science cooperation a third and main factor that should be employed for the basis of selection is the ranking of countries in terms of company-company and company-university cooperation. The ranking of these countries are taken from the World Competitiveness Handbook in Dodgson, (2000). The list is attained through the national and international surveys in which the respondents were asked whether technology transfer between companies and universities are sufficient, and whether technological cooperation between firms is common or lacking. Table 5 shows the results from this survey for both Asian and European countries.

Table 5. University Industry Cooperation 1999

Company-University Cooperation		Company-Company Cooperation
Country	Ranking	Country
Finland	1	Finland
Singapore	2	**Israel**
Israel	3	Japan
Netherlands	4	Germany
Switzerland	5	Denmark
Sweden	6	Singapore
USA	7	Sweden
Canada	8	Canada
Ireland	9	Iceland
Denmark	10	Taiwan
Australia	11	Netherlands
Taiwan	12	Switzerland
Germany	13	USA
Norway	14	Luxembourg
Iceland	15	Norway
Belgium	16	Australia
Colombia	17	Ireland
New Zealand	18	New Zealand
Austria	19	Belgium
United Kingdom	20	Austria
Hungary	21	Malaysia
Hong Kong	22	France
China	23	Hong Kong
Malaysia	24	Hungary
South Africa	25	China
Japan	26	United Kingdom
France	27	Russia
Russia	28	Spain
Luxembourg	29	Slovenia
Philippines	30	Poland
Chile	31	Czech Republic
Spain	32	Greece
Czech Republic	33	Italy
Greece	34	Philippines
Brazil	35	South Africa
Turkey	36	Brazil
Korea	37	Chile
Portugal	38	India
Italy	39	Turkey
Thailand	40	Argentina
Poland	41	Mexico
Argentina	42	Venezuela
Mexico	43	Portugal
India	44	Korea
Slovenia	46	Indonesia

The top-twenty countries of this list are considered successful examples of cooperation. Moreover, as Israel is second and third in this list, it would be reasonable to concentrate on the top ranking countries for a viable comparison. Indeed one of the main factors behind the Israeli achievement is the incorporation of powers and cooperation. The Office of Chief Scientist programs provide a gross national industrial R&D budget by centralizing to share the R&D costs to undertake bigger projects than the individual ones, as well as facilitating dissemination of information among the Israeli R&D and industrial players.

A fourth point for the assessment of the R&D and innovation capacity is the amount of R&D personnel that a country has. This item is taken into account since employment grows much faster in high-tech industries than traditional industries thus any a country, which has more employment in high-tech sectors, will be more prolific in terms of job creation and wealth generation thus the countries having higher R&D personnel relative to its population has more potential of competitiveness. The Table 6 identifies the countries R&D personnel and population; thus, the list of countries is further defined and shortened. Moreover, the countries are grouped into two larger countries having both larger markets and R&D personnel, and the relatively smaller countries, which have smaller markets and R&D personnel.

Table 6. R&D Personnel (Researchers in Israel and selected OECD Countries 1999)

Country	Population	TR	GR	BR	HR
Canada	31,902,268	90,810	7,420	49,500	33.250
Denmark	5,368,854	18,438	3,918	8,575	5.722
Finland	5,183,545	25,398	4,115	10,555	10.395
France	59,756,983	160,424	25,187	75,390	56,717
Germany	83,251,851	255,260	38,415	150,150	66.695
Ireland*	3,883,159	7,825	300	5,098	2.245
Israel*	6,029,529	24,000	NA	NA	NA
Japan	126,974,628	658,910	30,987	433,758	178.418
Netherlands	16,067,754	40,623	8,048	19,359	12,740
Norway	4,525,116	18,265	3,037	9,737	5,521
Singapore	4,452,732	12,568	992	8,055	3,552
Sweden	8,876,744	39,921	2,423	22,822	14,623
Turkey	67,673,928	20,065	2,197	3,247	14,621
UK	59,778,002	146,546	14,958	92,133	47,651*
USA*	280,562,489	1,114,100	49,800	1,015,700	135,800 *
Total OECD	N.A.	3,248,999	268,358	2,097,969	799,046 *
EU	N.A.	932,257	126.426	463,317*	307,151

Source:www.oecdnt.igenta.com/oecd/eng/wdsview/dispview.asp * 1997 data

Consequently, these four main items: (i) National expenditure on R&D, (ii) allocation of R&D expenditure among different sectors, (iii) financing among the private\public sectors, (iv) level of industry-science cooperation and (v) the amount researchers indicate the level and success of countries in R&D and innovation. They are employed to distinguish and select the countries especially relevant to the characteristics of Israel. First off, the selection revolves around top 20 countries from Table 5. Among these countries though the success of East Asian countries are not deniable the European Union countries and North American countries are chosen. Moreover, the countries with a higher GERD between 2 and 3, 5 are picked out from Table 3. For a further qualification for selection, the countries with relatively higher BERD and lower GOVERD are preferred over the others as while higher rates of BERD and lower rates of GOVERD signify the trends of developed countries (OECD, 1999).

Even after this narrowing down still most of the countries has a wide range of policies, and schemes thereupon the study focuses on the countries, with good policy practices and demonstrated favorable development in their innovation system. Among these countries, whose programs can be identified with the following features is picked out. Most of these countries have national innovation systems that cover a wide range of areas that goes beyond the scope of this research, thus the selection of the programs based on:

- Non-defense related public funding mechanisms that aim to strengthen academia and industry cooperation and clustering,
- Nation wide programs, which aim wide spread dissemination of knowledge,
- Center on pre-competitive research, with an interdisciplinary focus,
- Cooperative generic R&D in High-Tech industry,
- Involve relatively high number of network participant from all concerned sectors especially universities and\or knowledge centers,
- Having a central national funding from government and public domains, thus exclusion of supranational funding mechanisms.

However, concerning the last consideration, it is difficult to find sole national funding within the European context, since most of the programs are built on to benefit from EU sources. As a matter of fact, this singularity implies a difference among the measures.

Moreover, for a feasible and reliable comparative analysis with Israel, the study tries to select those countries with similar budgets and population to Israel, and more importantly those late industrialized countries of 90, which achieved a sudden development in knowledge-based economy. On the other hand, to refer to the success of those larger countries and to comprehend the general tendency of Triple Helix the analysis classifies two groups of countries. The first group of models is taken from Denmark, Finland, Ireland, Netherlands, Norway, and Sweden. They are examined in more details as reference group countries to the Israeli program. Those countries as well as Israel are ranked at the tops of World Competitiveness Handbook in terms of networking; they have almost similar size and population with Israel. Second group of models are taken from France, Canada, Germany, Japan, the UK, and the USA, as general representation of tendencies in developed countries.

4.3. Comparative Analysis and Observations

Innovation Programs in Developed Countries

4.3.1. International Comparison

After having selected the countries and national programs towards the academia-industry cooperation, this section presents the comparative analysis among these programs. It examines the cases to uncover the features of the Triple Helix model and achievement of successful partnership and satisfaction from the program. It addresses the 'reasons of the program, target groups, the organizational, financial, management structures; project proposal and eligibility criteria, intellectual property rights regimes, and socio-economic implications' as important parameters to compare and contrast national measures for innovation networking and comprehend the university-government-industry relations in an innovation network system. The lack of precise empirical data in the financial benefits, exact allocation of patents, or increase in the export rates are not considered as disadvantages for the composition of innovation typology policies.

The international comparisons are done with respect to two different groups of countries: (1) "Reference Group": Denmark, Finland, Ireland, Netherlands, Norway and Sweden, (2) Selected OECD Countries: France, Canada, Germany, Japan, the UK and the USA. [9]

The comparison with the Reference Group is done on more detailed items. The methodology for the selection of comparison items is based on the characteristics of Triple Helix Model that are presented in the literature survey.
The criteria for the comparative analysis are as follows:

- The goals and objectives of the programs, and their connection with network economies;
- The organizational and administrative structures (role of governments, stakeholders, intermediaries, intellectual property rights management, and implementation);
- The delivery measure (financial and funding structures);
- The project eligibility criteria;
- The results and impacts of these programs.

Subsequent to this first comparative clarification, the second comparative description between Israel and the Second Group Countries is made from a more general perspective to ascertain the success of the Magnet program relative to this large-developed countries and to state a broader application of Triple Helix. Ultimately, this section presents the general observations and tendencies among these measures to derive good policy practices in terms of Triple Helix system.

4.3.2. Israel and Reference Group

Israel's Magnet Program (Office of Chief Scientist), is compared with Denmark's Competence Center Contract Program (Agency for Trade and Industry), Finland's Centers of Expertise Program (TEKES), Ireland's Advanced Technologies Research Program (Enterprise in Ireland), Netherlands's BIT and

[9] See Appendix B for the analysis of the different national programs on networking.

Technological Cooperation Program (SENTER), and Norway's BRIDGE program (The Research Council of Norway).

4.3.2.1. R&D Inputs

When the R&D inputs of these seven countries are examined in Table 7, Israel has an outstanding place among these countries since while Israel has the lowest GDP per capita; except Sweden and Finland its GERD is higher than the other countries. Israel achieved this successful level by the having the highest percent of GDP allocated to R&D at the world level. Unlike the case of Ireland where production is higher, Israel gives equal importance to research and development. The critical point that is drawn from the Israeli case is the identification of priorities, though Israel has the lowest GDP per capita, this does not prevent Israel to allocate a competitive amount of resources on R&D.

Table 7. R&D Inputs

Economic Data	IL	DK	FI	IE	NL	NO	SE
GDP per capita	17,000	26,300	22,800	25,200	25,100	27,600	23,000
GERD per capita	673	521	701	269	462	464	732
GERD %	3.6%	2.0%	3.1%	1.4%	2.0%	1.6%	3.5%
GOVERD %	30.4%	36.1%	30%	22.2%	37.9%	42.9%	25.6%
BERD %	60.4%	53.4%	63.9%	69.1%	48.6%	49.4%	68.8%
Population	6,029,529	5,368,854	5,183,545	3,883,159	16,067,754	4,525,116	8,876,744
Total Researchers	24,000	18,438	25.398	7,825	40,623	18,625	39,921

4.3.2.2. Goals and Objectives

Table 8 presents the objectives of the programs. The main motivations of the programs are to bring competitiveness, industrial growth and innovation capacity of countries by way of increasing the interaction between industrial bases and academic bases of the countries. Generally, the aims of the measures are the promotion of joint innovation projects between industry and universities in order to improve and continue the industrial competitiveness of the countries.

Table 8. Program Objectives

Objectives\country	IL	DK	FI	IE	NL	NO	SE
Commercialization of knowledge.	√	√	√	----	√	√	√
Increasing competitiveness	----	√	√	√	√	√	√
Increasing innovation	√	√	√	√	√	√	√
SMEs	√	----	----	----	----	√	----
Start-up of high-techs firms	----	----	----	√	----	√	√

Beyond these motivations while the Israeli, Norwegian, Sweden programs are giving emphasis to the factor or necessity of 'absorption of new technologies by SMEs' the other measures have not specifically address this issue. Second of all, Israeli, Finnish and Dutch programs explicitly underline the importance of strengthening the innovation capacity of companies.

4.3.2.3. The Organizational Administrative Structure

All of the programs are initiated by governmental initiatives, they are organized according to top-down approach of innovation networking, and the governments' agencies provide the institutional, legal and financial structures necessary for innovation networks. The governments primarily undertake the following roles.

Table 9. Role of Government

Role of Government \ Country	IL	DK	FI	IE	NL	NO	SE
Administrator	√	----	----	√	----	√	√
Catalyser	----	√	----	----	----	----	√
Facilitator\ Coordinator	----	----	√	√	√	√	√
Funder\ Investor	√	√	√	√	√	√	√
Launcher\ Initiator	√	----	----	----	√	√	√
Networker	√	----	----	----	----	√	√

This classification reflects the statement of Triple Helix model as the changing role of governments according to the country patterns. None of these countries has left their R&D, innovation facilities and thus industrial competitiveness into the hands of market mechanisms; instead, they are intervening in the innovation process on a reasonable level compatible with the market tendencies. They are acting on a limited but essential level that provides the propitious conditions for innovation partnership.

Intermediary and Bridging Agencies: Generally, all of the measures are operating under the umbrella of a governmental body, which is bridging the business sector, industrial research institutes, higher education institutes with the concerned ministries, recurrently such as ministries of industry, trade, economics, education or national agencies for research and technology. These agencies are acting as intermediaries between the funding, policy level and performers.

Table 10. Intermediary Bodies

Type of Intermediary Body\ country	IL OCS	DK AGTI	FI Tekes	IE Ent.IE	NL Senter	NO RCN	SE Vinnova
Advisory Councils	----	----	----	-----	----	√	----
Dedicated Organizations	√	√	√	√	√	----	----
General Organizations	√	√	√	√	√	√	√

The literature on the types of organizations argues that for effective management of innovation partnerships, the intermediary bodies need to have some considerable role in directing the way of ST&I policies and executive power in the implementation of these policies rather than just providing independent advice at arm's length. Therefore, the cross-country analysis correspondingly shows that these national measures are generally managed by active decision-makers, rather than people appointed on an ad hoc basis.

While in most of these countries, the number of agencies is greater than in Israel, it is the only OCS, which has the exclusive responsibility in the management of innovation networking in Israel. These kind of exclusive bodies are suggested as a more viable method for the developing countries in the management of innovation networks than the diversity of agencies. The integral existence and importance of these intermediary bodies are also reflecting another characteristic of Triple Helix.

Stakeholders and Participants: These programs try to comprise of all of the participants and stakeholders of innovation networks. The main target groups of these programs are as follows.

Table 11. Target Groups

Target Group	IL	DK	FI	IE	NL	NO	SE
Large Industrial	√	√	√	√	√	----	----
(Non-industrial) Companies	√	√	√	√	√	----	----
Industrial SMEs	√	√	√	√	√	√	√
(Non-industrial) SMEs	√	√	√	√	√	√	√
Universities	√	√	√	√	√	√	√
Research Institutes	√	√	√	√	√	√	√
Foreign Partners	No	----	----	----	√	----	----

Although the governments are funding and initiating the networking programs among the similar target groups, how they are organized and managed varies from country to country. As a reflection to the point in terms of company-company cooperation Ireland is 17th, Norway is 15th, and Netherlands is 11th and there is a need for higher business participation, qualifying the SMEs with R&D capacities and strengthening the competitiveness of industry, hence the emphasis is given to industrial participants. On the other side, Denmark is ranked 10th in university-company cooperation, there is relatively more need for strengthening the industry-oriented capabilities of research institutes; consequently they introduced bridging organizations such as GTS and other measures to facilitate the transfer of basic knowledge to industrial utilization.

Thus, all of these countries try to remedy their “major relative weaknesses” in terms of innovation generation (ETCI, 2001, p.12). The different tendencies or preferences according to the country needs explicitly reinforce the arguments of Triple Helix in terms of country specific projection patterns.

However, none of the countries within the scope of this study does not have only these measures, they have several complementary policies and programs that work within the scope of national innovation systems. Thus in each of these programs the role of the government and the target groups may vary, or overlap.

Implementation: As for the attainment of Triple Helix model, definitely these programs are designed for the interactive innovation process between universities and industry. There are central requirements in all of these programs such as the establishment a team of project, in an active cooperation of certain number of universities and research institutes. Second, it needs to be comprised of large number of industrial participants and it should be open to the newcomers as well. The programs considered to be legally binding agreements between the participants. They are acting under the terms of these measures; this causes them to be the one department of a big firm working mutually for the same objective. The coordination of this ‘big firm’ is realized generally by a committee, which represents the ministries of industry, economics and science and technology councils. They also include representatives from industry and academia. These committees are responsible for the financial and administrative relations of the partners.

Management of Intellectual Property Rights: Concerning the management of intellectual property rights, the Magnet Program demonstrates remarkably a good policy measure concerning the achievement of equity in sharing, widespread dissemination, as well as its utilization as an economic gain by the whole consortium members.

The Danish Case states the actors who participated in the development of the project, has equal rights over the IPR. However, the dissemination of new knowledge outside the project teams are given great importance. Among other programs, the general tendency is to leave the final decision to the members of the consortium. They execute their own method about IPR management. This literally coincides with the Triple Helix attribute for the management of IPR.

4.3.2.4. Delivery Measure (Financing)

The governments financially support the programs. The percentages and the budget allocations, the possibility of additional funds varies from country to country. The common point is while the governments undertake the highest burden, the participants are supposed to contribute to the development of the project. Table 12 shows the details of budget allocations.

Table 12. Financing of the Program

Mode of Delivery \ country	IL	DK	FIN	IE	NL	NO	SE
% of Government Funds	66-80%	50%	50%	100%	Min.50%	----	50%
Overall Budget	Un	NA	NA	€ 5, 725bn	----	----	----
Expenditure\year (2000)	$ 75M	13	€ 5 M to dozens of Million.	P. 100,000 -400,000	€ 50M	Eu15.8M	€ 650,000-900,000
Industry Share	----	25%	50%	----	----	√	50%
Research Inst. Share	----	----	----	√	----	√	Vinnova
Higher Education Share	----	----	----	No	----	----	Vinnova
Additional funding	Sharer	√	√	No	Mx.50%	NA	EU
Duration of Partnership	5yr+1yr	C	C	3yr	4yr \ C	C	3yr

Un: the measure has unlimited time duration, so there is no overall budget
Eu: EURO, M: million, C: The duration of the project depends on the completion on the project
P: UK Pound.

According to Table 12, the governments are providing the higher shares of the program budgets from at least 50 to 80 percentages. Even in Ireland, the government covers the whole budget. Israeli government is allocating the highest amount of money for the measure.

However, in the case of Israel, any additional governmental funding is forbidden and only the program participants are supposed to fund the program. In most of these countries additional financing, especially benefits from the EU programs are very influential in these program funds. Moreover, according to the European Trend Chart on Innovation, under the direction of cooperation for innovation, between industry and university, while there is one single measure Magnet is introduced in Israel, in these countries the number of the programs in this field is definitely higher than Israel (ETCI, 2000). This reflects the fact that Israel is operating in this field solely by its national budget, for further improvement Magnet consortia can be suggested to be open to foreign financing as well. However, according to the results of the evaluation report of a consulting company most of the respondents preferred Magnet to operate on national resources, and underlined that there are sufficient number of international programs.

In Magnet, the consortia projects should be completed within 5 years and it can be extended up to 1year, in the other cases it is designed on 3-years duration or it is an open-end program. In terms of the project duration, Magnet has a reasonable time-span. It is long enough to acquire the long-term results of research and it is short enough to spur the benefits of opportunities of an innovation. The classification on the financial management of the programs evidently reflects the requirement of innovation networks regarding cost and risk sharing among the participants. Although it is difficult to enumerate them in an ascending order from the best application to the least one, there are still some conjectures for a late coming country.

Concretely, while the governments undertake the higher burden, they need to make the business contribute at the utmost possible level, and finance their own costs, while the participation of research institutes and universities should be financed by the (conjectural) program. Table 12 does not show detailed data on the overall budget allocated for the measure (except Ireland).

This tendency can be calculated as a positive indicator for developing countries, since generally they have instabilities in budget allocations for the longer-terms, thereupon they do not need to be concerned so much with the details of overall budget allocations. On the contrary, for a successful functioning of the measure, it needs to have a stable and increasing budget allocation at the optimum level it needs to be refrained from any macro-economic instability, which seems to be very difficult for the developing countries to achieve.

4.3.2.5. Criteria for Eligibility

The application to participate in these measures can be realized via a research institute or it can be done by individual researchers, or group of organizations. While a partnership between academia and industry in advance provides an expeditious initiation, the program committee can act like a matchmaker and bridges the partner. Extensively, whether they are prior partnerships or joined under the framework of the measure, they are subjected to the rules of the program. The following table shows the different types applicants. Under the conditions of a developing country, the beforehand partnership seems to be difficult to achieve, thus these programs should be designed to bridge and administer these two settings.

Table 13. Applicants for the Programs

Type of Applicant	IL	DK	FIN	IE	NL	NO	SE
Group of Companies	X	√	√	√	√	X	√
Individual researcher	X	√	√	√	√	√	X
Industry & Academia	√	√	√	√	√	√	√
Industry / business	√	√	√	√	√	X	X
Research Institutes	√	√	√	√	√	√	√
Universities	√	√	√	√	√	√	----

√: participant X: non-participant

In addition to the sort of participants for application, the committees of the programs apply similar or different criteria to decide the eligibility of the project propositions from these applicants. These criteria reflect the requirements of knowledge-based economy and objectives of a successful Triple Helix system. Table 14 classifies the governments' industrial priorities in initiating these programs. This classification is based on the programs' frameworks however it there are no sharp lines among the program objectives, or some points are totally neglected.

It should be kept in mind that though there are national variations, by and large the critical points in accepting or rejecting the proposals are how much they are promising to bridge the producers and users of knowledge and how much the program contributes to the industrial competitiveness of the country. Table 18 tries to itemize each programs specific or overlapping aspects. It aims to show the omnipresence of the arguments of a successful innovation partnership in these national partnership programs.

Table 14. Project / Program Evaluation Criteria

Criteria	IL	DK	FIN	IE	NL	NO	SE
Active participation	√	√	√	X	√	√	√
Basic Science→Applied Science	√	√	√	√	√	√	√
Concrete solution	X	√	X	√	√	X	X
Cost & Risk reducing	√	X	√	√	√	√	√
Dissemination of technology	√	√	√	√	√	√	√
Employment oriented	√	√	√	√	X	√	X
Export oriented	√	√	√	√	X	√	X
Financing Requirements	X	√	X	X	√	X	√
Generic technology	√	X	√	X	X	X	X
Initiate& useful for SMEs	X	X	√	√	X	√	√
Knowledge pooling	√	√	√	√	√	√	√
Large number of Participants	√	X	X	X	X	X	√
Open to newcomers	√	X	X	√	√	X	X
Targeted at priority areas	X	X	√	√	√	X	√
Technological innovation	√	X	√	X	√	√	X

Table 14 also reflects the objectives of the national programs. The classification of the criteria for the acceptance of the programs in details underlines the utilization of the aims of innovation networks by each of the program. Hence, it can be concluded that as higher as these items are taken into account in the assessment of project proposals, the higher the success rate of the programs.

It is necessary to emphasize that the criterion of 'concrete solution' is only employed by three countries 'Denmark, Ireland and Netherlands. Accordingly, it can be stated that the main aim of the networks is not to end in results but to provide the necessary conditions for production and any kind of problem solving. Another point is that the Magnet program covers and addresses larger constituents of a successful partnership that is stated by Triple Helix innovation networks. Additionally, Israel conceivably undertakes a foresight study and defines its priority areas, as some of these countries identified their target areas such as ICT, bio-technology and electronics.

These items can be grouped under four main headings to be applied as eligibility criteria: "success in technological innovation, high results of economic benefits, commercial potential and active cooperation of participants from industry and science". These factors should be taken into account in assessing the project propositions.

4.3.2.6. Results and Implications of the Measures

Definitely, this is the most difficult part to discuss since primarily there is not enough official data on the results of the programs, or there is no unequivocal indicator to figure them out. Second, since the national innovation systems are composed of many measures, which are working in cooperation with other national and international programs the net results of these programs are difficult to distinguish from the impacts of the other measures. Moreover, even though all these countries have high innovation performance, the variations make national comparisons on strictly defined items difficult. Therefore, in each of the country reports the achievement of the project criteria, the general positive observations on the programs, or at least continuation of the programs and increase in their budget are considered as the programs' positive implications and achievements. Table 15 shows the indicators of success, rather than net profits of the program. Nevertheless, any unchecked indicator does not mean a total failure at or ignorance of that factor, rather this is due to the lack of data or a complementary connection.

Table 15. Indicators of Success

Implication	IL	DK	FIN	IE	NL	NO	SE
Accomplishment of Targets	√	√	√	√	√	√	√
Budget increase	√	√	√	NA	√	√	NA
Efficiency in Gov. role	√	√	NA	√	NA	NA	NA
Enhancement of R&D	√	NA	√	NA	√	NA	NA
Extension of program	√	√	√	√	√	NA	√
Increase in competitiveness	√	√	√	√	√	√	√
Increase of U&I partnership	√	√	√	√	√	√	√
New companies & jobs	NA	√	√	√	NA	√	NA
Superior achievements	√	NA	NA	NA	√	NA	√

By and large, the programs are considered to fulfill their initiation targets, and contribute to the intensification of university-industry interaction, which is very instrumental for further innovation. Another success sign is the extension of these programs, reflecting the acceptance and effectiveness of these programs nationwide. Moreover, an increase in their competitiveness, and in the availability of employment opportunities are also considered as the impacts of the program. At different levels and on different items, these measures indicate that a successful Triple Helix modeled innovation system may result in such a way as well.

The measures are designed to achieve the targets of a fruitful university, industry and government cooperation, which Triple Helix model expound to incite. The Table 15 rates the success of programs in the accomplishment of a trilateral networking.

Table 16. Expenditure per year

Year\country	IL	DE	FIN	IE	NL	NO	SE
1995	$15M	€6M	NA		NA	NA	NA
1996	$36M	€12M	NA		NA	NA	NA
1997	$53M	€12M	NA		€9M	NA	NA
1998	$61M	€10M	NA		€11M	NA	NA
1999	$60M	€13M	NA		€18M	€13, 3 M	NA
2000	$70M	€13M	NA		€22M	€15, 8 M	NA

Excluding Ireland, Table 16 also shows that the budget allocations per year for these programs are on the rise. The increase in the budget allocation reveals the satisfaction from these programs, and conjecturing of greater success for future. Especially in the Magnet program, the budget allocation shows a steep rise since its initiation. This confirms a concrete contentment with the Magnet and consensus for its success and continuation. In the Irish case, as there is an overall budget allocated for the measure, this indicator cannot be applied. Still it has relatively a larger budget for the whole networking measures (see in Appendix B.3, p.200). In the cases of Finland and Sweden, the programs are operating on increasing budgets annually and they are open to additional funding. Although it is not resulted from the exclusive, unshared contribution of these programs, the impacts of these programs on the overall innovation scores are considered positive. Subsequently, in the light of this conjecture, to assume a positive correlation between these programs and countries' high performance and "major relative strengths" would not be misguided (ETCI, 2001, p.12). It can be concluded that the Magnet's codes of conduct demonstrates a good policy practice compared to the success of Reference Country group in achieving the arguments of the Triple Helix model.

4.3.3. Israel and Second Group Countries

In this part Magnet program is compared with Projects on Key Technologies of France; Networks of Centers of Excellence Program (NCEP) of Canada;

Networks of Competence Program (NC) of Germany, Contract Research Program (CR) of Japan, the LINK scheme of UK and the Engineering Research Centers (ERC) and Industry/university Cooperative Research Centers Program (I/CRC) of USA.

Table 17. R&D Inputs

Economic Data	IL	CA	FR	DE	JA	UK	USA
GDP per capita	17,000	25,900	21,900	23,600	24,500	22,300	33,900
GERD percapita	673	411	424	544	723	346	775
GERD %	3.6%	1,6%	2.0%	2.0%	3.0	1.6%	1.6%
GOVERD %	30.4%	31,2%	40.2%	36.1%	19.3%	31.1%	29.2%
BERD %	60.4%	49.3%	50.3%	53.4%	72.5%	47.3%	66.8%
Population	6,029,529	31,902,268	59,756,983	83,251,851	126,974,628	59,778,002	280,562,489
Number of Total Researchers	24,000	90,810	160,424	18,438	658,910	146,546	1,114,100

These countries are classified as large-developed countries according to OECD, 1999 Report. They used to have relatively strong S&T and economic structures. However, they also need to initiate ST&I programs that foster interaction between university and industry and transfer of basic knowledge into market, for the continuation of this strong structure, and more strikingly in order to cope with the challenges of new economy and rise of new competitive economies. These measures are based on the attributes of Triple Helix model as well. These countries also reveal exemplary innovation performance and policies for university-industry cooperation that contribute considerably to the overall competitiveness and strength of these countries. They have evidently larger economies, domestic markets and human capital than Israel and reference countries have. What these bigger countries and economies achieved noteworthy concerning the Triple Helix of university-industry-government relations are discussed below.

Magnet has a committee, which is composed of governmental members, and only two representatives from high-tech industry and academia, and this body appoints the each consortia management. The Canadian National Centers of Excellence has a board of directors and it is responsible for the management of 25-30 projects on 4-6 themes.

It has a bigger composition of 20-50 companies, 12-20 universities with 50-60 professors and research institutes with 100-150 participants. Though the projects have single budget, industrial and governmental members are not eligible to receive these funds. However in the case of Magnet the budget is exploited by the consortia members as a whole. Although it is difficult to compare the two models, the Magnet program is a much more suitable framework for the developing countries than the NCE since the administration of each consortium is definite and different it would be easier and efficient administration. Secondly, as it provides equality to partners to access the resources, it renders the commitment of participants to the projects.

In terms of project eligibility, NCE appraises the project strategy to train highly qualified personnel and to increase the marketability of them according to the needs of industry, and second compares the synergy of the proposed projects with the other initiatives. This is the replacement of normative control by the reflexive focus on unintended outcomes. This reflects the importance of the synergy and codes of communication between them can determine the success or failure of the project. Likewise, instead of fixed ends and assumed yardsticks to assess the projects, the system needs to recreate the parameters for assessment according to the market potential and competitors. Up to a point, this provides to evaluate the program to be rewarding or not.

An additional point in the Canadian case is an itemized and precise evaluation report. It states the amount and percentage of spin-off firms, accepted patents, awards, licenses, new jobs, and employees. Additionally they assessed the training of students as highly qualified personnel in the R&D and innovation areas. In addition to the success indicators of Reference Country Cases (see Table

19 and 20) these items are needed to be included to the list of evaluation criteria. This evaluation report provides an exemplary guide that needs to be modeled by other countries for the evaluation.

Likewise, in Germany the central theme is to reform the education system that may impede the cooperation between academia and industry. Similar to the Magnet committee, the German measure, Innonet is organized under Technologienzentrum, which means Technology Center in German. However, instead of direct funding to the participants, this body provides 0.5 million Euro for the setting up of the platform between the participants for communication and networking. Additionally 2 million Euros for management and marketing rather than R&D activities. Among this wide variety of programs, Innonet aims to link competitors as well. Even though it is difficult to achieve, it has the highest social payoffs, and it is a good test base to figure out competitor's conflict causes more creativeness and competitiveness rather than dismantling market economies and creating oligopolies.

The Japan case indicates another dimension of Triple Helix model. Most of the measures are aimed to allow the academicians to work with industry and to change the strict research and teaching culture of academia into development and production. The Japanese Contract Research Program is designed not only on the restructuring of academia but also it allows universities to employ industrial scientists and engineers on a contractual basis to conduct research. This experience resulted in great economic benefit for universities. The legal framework is executed within the existing framework of participants, rather than allocating money for the establishment of a new setting. This provides discretion power for developing countries to comprehend the best possible way for Triple Helix model. At first the developing countries may initiate such programs without dedicating enormous budgets to test the feasibility of Triple Helix system within their context, and then try to figure out the obstacles on the way to Triple Helix.

However, nonexistence of the conclusive commitments from the participants or the lack of necessary financial investments may impede a precise discernment over the impacts of the anticipated model hence it is still necessary for developing countries to undertake definite policies.

The United Kingdom's LINK program particularly aims to accelerate the transfer of knowledge from universities to industry. The aim is not the creation of alternative research centers; the program does not provide the complete institutional setting for the management of the network, R&D facilities and the intellectual property rights. Therefore, eligible proposals are required to demonstrate a potential market, business plan, and administration structure as well as collaboration agreement over the sharing of intellectual property rights. As LINK does not provide the participants with the general administrative framework, it seems difficult to apply this model in developing countries since their ST&I infrastructure is not fully-developed to introduce a self-management system or to tackle with the systemic failures.

The Engineering Research Centers and Industry-University Research Centers of the US focus on the advancement of human capital, training of students and develop a new kind of engineer who is able to link basic knowledge with industrial needs. Second, these centers need to become self-sustaining within 5 to 10 years. Interestingly, even though the US cases are difficult to be modeled and achieved by the developing countries; the Australian Cooperative Research Centers Program, Korean Engineering Research Centers, Chinese cases are based on the US experience and they perform good results for these countries as well. Certainly, it reflects the fact that an earlier custom-made modeling provides these countries with the opportunity of accelerated development or at least national strategy for shaping ST&I and R&D priorities. In addition to these centers the USA made a legislative change in its anti-trust law. It allows the establishment of pre-competitive R&D consortia such as SEMATEC, CATS, Bellcore are established under the recent framework of National Cooperative (see Appendix B.12, p.229 for details)

Additionally, the French case mentions the importance of practicing of international trends for forming innovation networks, and necessity to follow them. This policy understanding evidently manifests the validity of updating and reshaping of S&T and innovation agenda according to global trends. Thus, it is inevitable for a developing country to follow the main and successful trends.

Similar to the German and Canadian experiences the French model also emphasizes the priority areas. These models identify ICT, natural resources and environment, human development and biotechnology, engineering and manufacturing areas as critical areas that have more payoffs than the other traditional sectors.

To conclude, these two types of comparative study suggest that the small modernized, innovation based economies (Reference Group) manifest a more tendency towards the features of the Triple Helix model. The programs of large countries are much more diverse, but still complementing each other towards the Triple Helix system. The facts that ‘reference countries’ do better than the larger countries are to some extent based on these smaller countries are concentrating on fewer sectors, and neither the budget nor the success is diversified. They achieve the power of ‘critical mass’ easier and perform more success in their dominant sectors (e.g. Finland and Sweden in the ICT sector). The industrial distributions in the larger countries are much more diverse extending from low and mid to high technology sectors. The programs are also designed to respond this diversity and it can be inferred that these countries score to the average of much more diversified innovation areas rather than a complete specific sector.

4.4. General Tendencies

4.4.1. Lessons Learned in Developed Country Cases

According to the comparative analysis above, most of these countries have identified similar policy priorities. They are facing similar opportunities and challenges thusly formulate similar policies.

This section presents similar and different tendencies of these programs as a whole. A list of several determinants for the successful innovation framework is derived from the comparative analysis. However though they are not miraculous tools for an immediate innovation success at the national or international levels, they are important tools to derive some complementary policies for Israel, and to suggest an optimal policy framework for networking in Turkey. Moreover, they are important in harmonizing international innovation networks standards and in making a more auspicious networking policy.

In fact, the new international innovation networks are likely to replace the multinational companies (MNCs). Even though some people may claim MNCs as the main tools for cross-national technology transfer and development, they are acting in a chaotic environment of globalization and only to be guided by market and individual self-interest. As Dosi and Orsegino (1988 in Castro et al. 2000) argued that markets have limited capacity to coordinate these independent and individual acts and they are unable to maintain a developing economy and knowledge base. Accordingly, they stated the necessity of a dynamic and coherent system with other forms of institutional organizations to manage the relations between economic actors and especially provide the industrial actor with access to knowledge centers. This new setting is highly influenced by the policies developed by nation states. Therefore, the indicators are assumed to help the harmonization of international standards for innovation generation and management. However, these determinants need to be embedded into the whole systems as to be effective and meaningful.

The reflection of the features of national policy-making to the international innovation policies and the need of regulation for the innovation activities instead of the invisible hand of market stresses the importance of nation states. This point clearly weakens Gibbons and his colleagues' claim that while firms became the centers of innovation, universities started to lose power, and the argument that nation states lose power because of globalization. Regarding the role of academia the demands of cross-national knowledge exchanges, importance of mobility of researchers and constant screening of global knowledge developments reveal the importance of academic knowledge beyond the scope of industry-based knowledge.

4.4.2. Observations and Complementary Points

4.4.2.1. Governments

The case studies demonstrate how governments keep on having a crucial role to render cooperation between the economic actors and knowledge producers since much of the research activities are done in governmental research centers and universities. Secondly, innovation is a high-risk investment, results of the projects are not certain, and the industry decline to involve in innovation. Thus governments which are the controller of most of the financial resources can initiate and undertake such big projects. Nation states rather than losing power due to globalization, they need to occupy an important position for the networking of actors, stabilization of the markets and for the direction and definition of future policies. Opposed to this view, there are the claims of insufficiency of the government departments to decide the right technological sector (OTA 1990 in TUBITAK, 1994). However, most of the time governments are the most informed bodies about the capacity of nation, and they have the necessary funds to launch such programs.

The initial motivation comes from government. they are providing not only financial needs but also they are setting the institutional framework for the cooperation between universities and business. The government is a synergist and actively participates in the industrial affairs of the country. Thus as opposed to the general view in developing countries such as liberalization and non-interventionism in economic affairs, the governments need to involve in industrial and economic affairs as a catalyst. They need to combine the right people with the right institutional setting and rules; otherwise, these actors cannot incorporate effectively by themselves.

4.4.2.2. Objectives and Goals of the Program

The next observation is the identification of national objectives and main goals, thereby formalization of national strategies and vision to achieve these objectives. The selection of the main objectives of an innovation program is crucial. There must be a balance between industrial social and defense goals. Since innovation is a very risky and costly process it should be responsive to a wide range of needs rather than a one specific target, however, any miscalculation of the aims, inaccuracy or one-sidedness between the goals lead to fruitlessness and vainness. In brief, the aims of the program must be defined at the beginning, otherwise absence of appropriate aims may prevent the establishment of appropriate strategies and policies. However, within the context of developing countries, due to the political pressures it is generally difficult to clearly identify the national innovation priorities, and strategy-making process is derailed easily. As a remedy, either successful foresight studies should be undertaken or at least the experiences and trends from successful countries should be taken into account as a standard.

4.4.2.3. Management Strategies and Policies

The above cases show that though a number of actors are involved in the innovation policy-making and implementation their actions are coordinated to prevent doing cross-activities or mismatches. There should be coherence between general economic, social and industrial policies as to generate synergy within the system. These policies must complement each other. Moreover, as innovation is a dynamic but a long-term process, which requires consistency, they must be designed as flexible and responsive to the rapid changes.

The innovation strategies and policies need to be subjected to the changing economic and industrial conditions at the national and international levels, rather than political considerations. They need to renew themselves, competent enough to tackle the current dynamic situation, and prevent falling into vicious circles. Therefore, while these strategies target at for seizing the benefits of knowledge-based economy, they should consider the longer-term possibilities as well. Finally, as innovation is full of positive–negative surprises these programs do not have exact claims and results. They are designed on realistic assumptions. Thus at the outset developing country policy-makers recognize the risks of innovation and limitations and capacities otherwise if over optimistic expectations are unmet it may cause disappointment and termination of the programs (Rotwell and Zegweld, 1990).

A further observation is the necessity of shift from "central management to tailor-made management" in these programs for the execution of those identified objectives (TEKES, 2001, p.11). These eminently innovative countries have far-reaching national innovation systems having a wide variety of sub-programs functioning under the government cabinet with a central body on the top. However, these mission-oriented programs are managed more exclusively according to their own codes of communication especially regarding to IPR, knowledge sharing and innovation process, which enable them to have ownership of the program, decision-making authority. This improves commitment to the program, they respond to changing conditions, customer needs, understand the complexities of innovation easier, and incite more innovation. The main lesson for catching up countries is to decentralize services and activities to the lowest level possible in these mission-oriented programs, to render non-hierarchy and to spawn more opportunities for the core players to execute core work of the program.

Thus, the government of a catching-up country needs to balance the policies of central management of innovation system with the specificity of the expectant program for university-industry-government cooperation. They need to provide the room for the maneuver of the participants free of political constraints.

4.4.2.4. Bridging Institutions

On the other hand, this decentralized management is much more difficult to manage; it may induce independent actions and stimulate different interests. In addition, it may cause the risk of unwanted opportunities leading to inequality and misuse. These may prevent the commitment of partners to the network and slow down the speed of R&D. Thus, governments are striving to establish new mechanisms that provide coherence and mutuality in performing innovation (TEKES, 2001). The strengthening of intermediary bodies and knowledge linkers are offered as a remedy to the coordination difficulty of networks. They are supposed to cajole and urge these different institutional settings to work cooperatively and thus prevent any inequality among the participants. Complex coordination mechanisms should be designed to align long-term strategies and gains of different institutions involved to facilitate complementarities.

In the comparison part above, the Israeli OCS and Magnet Committee have been described as a proficient example of intermediary body, which is dedicated to the mission and effective in policy and decision-making. Moreover, within each of the specific program there employed a ‘network initiator, academic coordinator, program managers, technology brokers’, responsible to coordinate the each project or consortia. They are very indispensable to facilitate the difficult relationships between competitors. They are the ones who know the funding opportunities, and have access to government initiatives.

Catching-up country policy-makers need to initiate such effective intermediary institutions as well as need to appoint competent managers for the coordination of projects. The coordinators must be very credible, accepted by the group and must have strong technological, industrial and management capabilities. They must be able to arbitrate relationships within the group and they must regard the success of the network as prominence for their professional development. Thus, the literature and the cases show that research organization or academic person that has links to the potential partners should be selected as the coordinator since they provide the trust from the beginning, however the risks of parochial tendencies must be observed strictly. The structure of Magnet and the role of academic coordinators can be contrived as an exemplary guide.

4.4.2.5. Central Policy Themes

Another feature is the Central Policy Themes of the programs. They evolve around synergy creation among performers, primarily between academic scientists, industrial researchers, and entrepreneurs. Even though it is still somewhat conditioned to industrial performance All these countries allocate special budgets to transform the science base to become more industry oriented and they actively support the promotion of basic science and research to secure the bases for future technology innovation. Another policy point is the stimulation of SMEs as they are the impetus for competitiveness and motor for job creation. Likewise, the support for the rise of national technology-based start-up and spin-off companies especially focused on ICT, biotechnology, electronics are in the agenda of these programs. Moreover, much as the programs are nation wide, they are stimulating regional development either in order to enforce the important national locations or to contribute to the development of lagged regions such as in the cases of Finland, Norway, Germany, Canada, and Sweden. These themes are the specific value added of these measures.

It is apparent that the network program needs to clarify what kinds of contributions will be made, and how they relate to the objectives of the scheme. In light of these facts, instead of importing technology a catch-up country has to increase its own technology capacity and capability regarding these central approaches. Relating to this while realizing these themes there should be a balance between high-tech money making and mid or low-tech job provider sector. To some extent, even this policy objective can be a driving force between the developed countries and developing countries for further cooperation.

Within the context of Israel it is also an advisory issue to strike a balance between these two sectors as approximately 300,000 out of 380,000 employed in mid\low-tech industry (Teubal, 1999)[10]. Small countries are generally focusing on one sector, and became the competitive leaders of these sectors such as Sweden and Finland in ICT. However, in case there is a radical change in the market, there is the risk of losing the competitive positions. In due course while a catch-up country strives to be competitive in high-tech sector, it seeks to balance between high-tech and mid or low- tech industries where most employment is located (Teubal, 1999). The catch up country needs to define its priority areas, if possible according to a national foresight study or at least and with regards to more paying off sectors that are already identified by the leading countries, such as in the ICT, bio-technology, micro-electronics, new materials, and alternative-sustainable energy sectors.

4.4.2.6. Project Initiation

The supplementary issues are the implementation of the program. The teams should be composed of research organizations, universities and SMEs or large industrial companies. Specifically a successful project initiation generally comes from industry as they are better informed about the market trends (LINK, ERC, Innonet, TEKES). However within the context of developing countries, industry is already in a lagging situation, and has poor understanding of R&D. Thus it will be more propitious for them if the projects are initiated by research institutes or universities. Academia can be a driving force to provide knowledge, industrial trends and as act arbitrator for the competing demands of partners, and to build trust between them as in the case of Sweden (WAMP, Report 2001).

Beyond these, the catch-up countries need to consider project's industrial relevance, commitment to R&D, research and experience contribution of partners to the team, existence of previous cooperation between the partners and self-authority of partners. The credibility of network coordinator as guideline of a successful project initiation can also be taken into account for the project initation. Moreover, reflections on how the project results will be translated into practice, its potential for commercialization and expected time for the completion, what additional applications can be possible to be gained are further aspects to be employed for a project initiation. (WAMP, Report 2001).

4.4.2.7. Industry Meetings

Moreover, regular industrial meetings are essential in building teamwork for the improvement of knowledge exchange and sharing. These meetings should be designed so as to provide the members with exogenous knowledge and interactive learning. On top it most of these programs have bodies for the

[10]See Teubal, 1999 Table 5, p.15 for the Distribution of Employment and discussion on 'strategy

permanent screening of global technological developments and informing the members (Mowery and Oxley, 1995 in Castro et al. 2000), like publishing common newspapers or typically the Magnet's Information Center. It functions is under the responsibility of coordinators to provide the participants with the latest scientific and technological knowledge in their research area via common web page. Generally the academic coordinator and information brokers are organizing regular meetings to render negotiation on project contents, knowledge pooling and in some cases to disseminate knowledge outside the network. The Magnet Consortia meetings provide the participants with equal access to knowledge pools and intensify the interaction. These consortia become a virtual company on the net. The catching-up countries inevitably need to hold regular, interactive and full participant meetings in order to expedite knowledge exchange and pooling.

4.4.2.8. Project Work

Another key factor in the long-term success of a scheme is the degree of flexibility in the codes of communication of the program. This allows networks to become more responsive to the changing needs. Triple Helix describes it as the evolutionary aspect of innovation networks. Besides being open to new partners or abandoning existing partners, in some cases such as Finland, the programs have become more industry or customer driven; similarly, programs are divided into sub-programs, in Norway while Bridge give rise to Forny and TEFT, in Israel Magnet is behind Magneton even to some extent NOFFAR. Moreover, in Finland it is observed that the re-application of the same sense to other programs, even it is widely accepted to apply this mode for the re-organization of general innovation activities.

The program should be designed to renew itself and to avoid falling into a vicious circle. If necessary, they may redefine priorities and objectives of the measure.

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1 versus strategy 2' in Israel.

These facts enlighten the developing countries about the future plausibility of the programs and thus enable them to estimate any possible alteration in needs and to design more sanguine and promising measures.

4.4.2.9. Technology Transfer and Dissemination

The technology transfer within the consortia/network is the chief objective. The knowledge and technology produced within the network have to be accessible by all the partners. Any discrimination or concealment must be eliminated since this only produce limited technical learning compared to network results. Dissemination of research results to the outside of networks should be supervised with great responsibility. Otherwise, it turns to be oligapolistic, exclusive settings neglecting the socio-economic facts of technology dissemination. Magnet regulations on the IPR are satisfactory for these policies.

For a catching-up country it is also essential to achieve a higher dissemination of technology to the utmost possible level, they must be designed so as to avoid being an exclusive group of some big industries that exploit both the governmental and academic resources solely for their own profit. They must be required to share the technology with the small-sized participants of the network and outside of the network.

4.4.2.10. Evaluation /Assessment

Though evaluation is not a costless process, the lack of evaluation would cost much more, thus governments must bear this cost (Rotwell and Zegweld, 1990). Apparently evaluating the programs as simply successful or non-successful is a very difficult issue. Thus instead of considering the withdrawal of any party from the system as an indicator of failure; the accomplishment of program objectives and signs of contribution in terms of better optimization of R&D inputs, improvements in R&D outputs, rising employment opportunities, to the progress should be deemed as assessment criteria. In many cases the programs are assessed by consulting firms. Within a rational time span of 5 to 10 years, the programs needs be evaluated by external experts in order to make neutral, impartial conclusions. Briefly, the emphasis should be placed on the achievement of network of participants in the policy formulation and implementation process.

4.4.2.11. Full Network

Network is the forum for collective learning, communication, and synergy creation. The analysis on the cases bears out that the main success of networks is based on the achievement of energy of critical mass[11] and establishment of trust among the members. Involvement of end-users, customers and potential networkers enable the system to have the understanding of their customers' needs (SPRU, SAPPHO Study, in WAMP, 2001). Referring to the conditions of catch-up countries, the factors of trust and reliance neither within the industrialists nor between industry and university or even with state sector is difficult to achieve. Thus the governments are obliged to assure trust among the partners and their commitment to the system; they must pledge to continue the system despite of the political instabilities.

Generally, networks are the virtual, symbolic places of cooperation embody the image of a big company. The management of a big company is hard the administration of networks is arduous and requiring concessions, trust endurance and determination. Thus, the catch-up country should persuade the potential partners based on Luzt's[12] assertion for consortia. He stated none of the partner is calculating individual gains, but this is a matter of belief and devotion for the national competitiveness and development. None of the participants could have achieved such development in the absence of networking. It is not a win and lose

[11] The amount of substance that is needed for a nuclear chain reaction to take place.

game, but rather the achievement of exceptional R&D results through cooperation. He reasserted the impacts of networks are greater than the sum of their parts, because they are benefiting from the synergy of the system.

[12] Chief of Crysler and partner of Crysler-Ford-General Motors consortium.

CHAPTER 5

5. EMPIRICAL STUDY ON MAGNET

5.1.1. The Magnet Program

This chapter presents the empirical research that has been carried out among the participants of the Magnet program. The first part of the empirical research highlights some new features and provides some complementary points regarding the organizational and institutional formation of the Magnet program. Second, it states the factors that are integral for the formation of a successful networking within the Magnet. Third, the impacts of the Magnet are employed to clarify the contribution of the Magnet program to Israeli industrial and socioeconomic progress. Concerning the results of this examination, the specific organizational structure of the Magnet for the full utilization of national resources and bringing competitiveness at the global markets are manifested. Finally, Magnet's relevance to the arguments of Triple Helix is evaluated.

The questionnaire was responded by forty participants of the Magnet Program. Twenty-two responses are from industrial participants, composing 55% of the total respondents. 45% of the responses came from the eighteen non-industrial participant of Magnet either as academicians or representatives of Ministry of Industry and Trade. According to the responses of these participants the following items are analyzed to uncover the specific conditions for the network formation within the Magnet program.

5.1.2. Reasons and Rationale of the Magnet Program

The Magnet program has been launched in July 1992. It is not a direct offspring of any previous program. It is specifically designed for generic R&D rather than pre-seed or competitive R&D. In general, the reasons for the launching of the Magnet program corresponds to the general motivations of the Israeli Office of Chief Scientist R&D support programs. Specifically Magnet aims to strengthen the Israeli industry's technological expertise, and to enhance the Israeli competitiveness in international markets by an efficient pooling of academic knowledge and financial resources.

In a country of six million, the main rationale of Magnet is based first on the realization of cooperation and creating a 'critical mass of six million' for building new technologies. Second it is based on the efficient exploitation of national resources, by harnessing the knowledge of Israel's academic research institutes and encouraging the high-tech sector to access this scientific know-how through 'mutually beneficial cooperative programs'. Its aim is to achieve a more efficient allocation of financial and professional resources through scientific and technological cooperation between both industrial companies and academic research institutes and between themselves as well.

Indeed, according to the analysis of R&D expenditures and growth rates of different sectors given in Table 18, the R&D expenditure in business and higher education sectors display rather stable growth rates due to the positive relation between the OCS R&D grants (Mani 2000, Trajtenberg 2000). Furthermore, the networking of business and higher education sectors such as in the setting of Magnet is believed to provide more stable and higher increasing growth rates for Israel.

Table 18. Growth Rates in the Israeli Academy-Industry-Government and Non-Profit Sectors

PNP	Growth Rate	Gov.	Growth Rate	H.edu	Growth Rate	Ind.	Growth Rate	Ind & H.edu	Ind. & H.edu. total G. Rate
164	NA	260	NA	636	NA	2266	NA	2902	NA
173	5,49	245	-5,77	678	6,6	2319	2,34	2997	8,94
176	1,73	265	8,16	706	4,13	2536	9,36	3242	13,49
180	2,27	292	10,19	748	5,95	2733	7,77	3481	13,72
205	13,99	292	0	781	4,41	2921	6,88	3702	11,29
200	-2,44	282	-3,42	812	3,97	3143	7,6	3955	11,57
224	12,00	276	-2,13	842	3,96	3280	4,36	4122	8,32
223	-0,45	301	9,06	863	2,49	3577	9,05	4440	11,54
230	3,14	294	-2,33	903	4,63	3796	6,12	4699	10,75
243	5,65	299	1,7	945	4,65	4046	6,59	4991	11,24
252	3,70	299	0	992	4,97	4361	7,79	5353	12,76
	4,50		1,55		4,55		6,79		11,34

(**Source:** www.cbs.gov.il; PNP: Private non-profit sectors, H.Edu: Higher Education, Gov: Government, Ind. Industry, G. Rate: Growth Rate)

According to Table 19, remarkably 85% of the respondents considered the achievement of the better interaction between science and industry as the most crucial factor behind the initiation of the Magnet Program by the Israeli government. Similarly, pooling of national resources was regarded by 82% of the participants as another crucial rationale of the initiation of the Magnet. Even though better utilization of academic potential came as fourth crucial factor, after the increasing of high-tech export capability, it had lesser variation among the respondents. The relatively higher deviation in the responses given for the assessment of high-tech export capability is because of the straightforward participation of non-high-tech firms as much as the high-tech firms in the Magnet program.

Table 19. The Reasons for the Initiation of Magnet Program by the Israeli Government

Factors	Crucial	Important	Slightly-or not important	Mean	Std. Dev.
Better interaction between S&I	85,00%	12,50%	2,50%	4,17	0,957
Better utilization of academic potential	62,50%	30,00%	7,50%	3,65	0,975
Demands of industry	35,00%	40,00%	25,00%	3,15	1,050
Increasing high-tech export capability	82,50%	7,50%	10,00%	3,92	1,020
Pooling of National resources	82,50%	15,00%	2,50%	4,10	0,955
Reduction of relying on foreign technology	45,00%	30,00%	25,00%	3,32	1,340

On the other hand though it is initiated by the state, the initial demand came from industry which was looking for funds and new scientific knowledge. The industrial reasons to participate in the Magnet program overlaps with the rationale of government for the Magnet. As shown in Table 20, the main reason of industry is to access to the knowledge pools rather than cost reduction, immediate financial gains or market control.

Table 20. Industrial Reason for Participation in the Magnet Program

Factors	Crucial	Important	Slightly-or not important	Mean	Std. Dev.
Access to knowledge centers	82,50%	10,00%	7,50%	4,07	0,859
Competence gap	80,00%	12,50%	7,50%	3,92	0,888
Market control gap	37,50%	37,50%	25,00%	3,07	0,971
Cost reduction	50,00%	37,50%	12,50%	3,62	1,078
Information gap	52,50%	42,50%	5,00%	3,67	0,859
Profit maximization	50,00%	35,00%	15,00%	3,35	1,166
Risk reduction	67,50%	27,50%	5,00%	3,65	1,051

This provides industry with access to the academic knowledge and research pools while at the same time providing knowledge sharing and interactive learning among each institutional setting. The pooling of national resources accelerated the process of technological development, turning innovation into products more rapidly, shortening the time to market cycle of new generation products.

Even though the responses on the reasons for the participation of academicians have greater variance, industry committed research is stated by 67% of the participants as the most crucial factor with a lesser deviation than the other parameters. For instance, the higher variance for the matter employment opportunities for graduates is explained while some of the academicians especially from Be'er-Sheba University seek for this point; academicians from Technion consider it less important but emphasize the importance of applied research.

Table 21. Academicians' Reasons for the Participation in Magnet

Factors	Crucial	Important	slightly-or not important	Mean	std.
Financial Constraints	60,00%	30,00%	10,00%	3,65	1,160
Industry committed research	67,50%	27,50%	5,00%	3,75	1,000
Employment opportunities for graduates	45,00%	20,00%	35,00%	3,00	1,330

Since cooperation reduces costs, saves human capital, strengthens and expands technological activity for the mutual benefit of everyone involved the real incentive of Magnet is to create cooperation among these centers. This characteristic of the Magnet corresponds with the aim of the Triple Helix model of the achievement of interactive innovation process. In its entirety, the Magnet program aims to (i) promote clustering and co-operation between research institutes, universities, companies for innovation; (ii) strengthen company research conditions; (iii) increase absorption of technologies by SMEs' (Trend Chart on Innovation, 2000). Accordingly, the Magnet program is considered to fulfill its goals and achieve its raison d'ètre.

5.1.3. Participants of the Magnet Program

The target groups of Magnet are the domestic large companies, SMEs, research institutes, and universities. Admitting the consortia must be formed on the largest possible group of industrial members and academic institutions operating in the relevant technological field, the participation is open to all interested parties, but the participation is limited to Israeli-based companies or at least Israeli subsidiaries of foreign companies (Trajtenberg, 2000; CORDIS 2000). These groups form a consortium based on a contract stating its target, right and responsibilities of each partner vis-à-vis other partners and the consortium as a whole vis-à-vis the government.

As the success of relationship among the participants of networking system determines the success of a network, the respondents are asked to evaluate the success level of interaction among each other. According to Table 22, while few of the respondents considered the relationship slightly or not successful, most of them found it moderately successful or very successful. On the other hand, the interaction between the customers, which is the fourth component of the network systems, is found to be less successful compared to the multilateral and bilateral relation among the other parameters of the system. In fact, Magnet is designed as a pre-competitive R&D support program, in which the application of generic technology into marketable goods depends on the participants themselves. However, the information centers of the each consortium inform the participants about the market trends and needs. Consequently, the results will be applied more relevant to the market needs and less risky than current mechanism.

Table 22. Relations between the Participants of Magnet

Factors	Very successful	Successful	Slightly-not successful	Mean	Std. Dev.
Interaction between government & industry	50%	42,50%	7,50%	3,47	0,816
Interaction between government & university	30%	55%	15%	3,05	0,904
Interaction between	67,50%	30%	2,5%	3,8	0,822
Triple interaction	32,50%	55%	12,50%	3,25	0,742
Interaction between consortium and customers	22,50%	22,50%	55%	2,57	1,174

5.1.4. Organization and Implementation

Magnet is a directive by the General Manager of the Ministry of Industry and Trade and it is funded by the Office of Chief Scientist. The predominant role of government is to launch and fund the program. It is a top-down approach, with a new legislative and administrative structure; still it has room for bottom-up demands.

This double feed back mechanism provides the Magnet and its participants with effectiveness, appropriateness and promptness, which prevents any time or money losses by looking for the right partner. The Director General of the Ministry of Industry and Trade has appointed the Committee of Magnet to carry out the activities of the program. The Chief Scientist of the Ministry chairs the Committee. The other members are: Deputy Chief Scientist of the Ministry, Representative of the Budget Division, Ministry of Finance; Representative of the Ministry of Defense, two representatives from the high-tech industry, two representatives from academic research organizations, the Program Manager the Office of Chief Scientist, Ministry of Industry and Trade.

The Committee allocates the Magnet budget and appoints the National Boards running the diverse programs of 'Computerization, Microelectronics, Electro Optics, Materials and Biotechnology (Trend Chart on Innovation, 2000). The committee also appoints representatives to consortia management, users associations, and steering committees. The management of consortia is composed of one representative from academia; two representatives from industrial participants. This system provides impartiality and balance among the participants (MOIT, 2001).

The technology generated by the consortium must be generic and serve more than one enterprise. It cannot be acquired from abroad on reasonable commercial conditions and it has not been developed before and it must not be in use in Israel currently. It must enhance employment and exports.

The Magnet Program operates through two channels. The technology R&D Channel is the team of researchers, scientists, and industrialists who work cooperatively for the generation of new knowledge and technologies for further development of products.

The Distribution and Implementation Channel aims to enable 'User's Associations', which is composed of members of the same industrial sector or sharing common technology to access to the latest scientific and technological developments from abroad by implementing and integrating them into their own activities. This information exchange is accomplished through financing of lectures, seminars and professional get together, which takes place under the aegis of Magnet User's Associations (Mani, 2000).

5.1.5. Dissemination of Knowledge Outside the Consortium

Despite it is a common handicap of networks to achieve the transfer of technology outside the consortia at the desired level; Magnet program is designed to prevent any kind of monopolization. The consortia must do its best to distribute equal distribution of knowledge and technology between themselves, as well as to include additional partners working in the same field (Trend Chart on Innovation, 2000; Trajtenberg, 2000). Consortia members must make the research results of the Magnet projects available to all domestic parties at a reasonable price, refraining from any monopolistic power.

Table 23. Role of Magnet in the Dissemination of Knowledge

Very successful	successful	slightly-not successful	Mean	std.
37,50%	37,50%	25,00%	3,10	1,007

The intellectual property rights to the technology developed within the framework of Magnet program belong to the party that developed it; however, the results must be shared among all partners. The sale or transfer of technology developed with the government assistance to foreign parties is subject to the approval of the committee (ETCI, 2000).

5.1.6. Role of Cooperation and Synergy in Magnet

Beyond the roles of domestic and international as well as institutional setting of Magnet for the formation of successful networks in Israel, the survey identifies the importance of the cultural and societal features of the Israeli society for the creation of the synergy within the networks.

As shown in Table 24 the achievement of the synergy of the participants was dominantly pointed out very important for the success of the program while few of the respondents considered it slightly or not important.

Table 24. Role of Synergy in the Magnet Networks

Crucial	Important	slightly-or not important	Mean	std.
87,50%	10,00%	2,50%	4,17	0,712

The participants were asked to evaluate various parameters, which are stated by the literature as integral for the creation of synergy in the networks. According to Table 25, the efficient management of the board of consortium is rated crucial by the 90% of the respondents. Moreover, the trustful relations, similar objectives, collective belief and equity among the participants. Application and use of information communication technologies (ICT), funding and research stability, efficient management of the board of the consortium, consensus over intellectual property rights are regarded to expedite the generation of the synergy of the participants. Indeed, 86 % of the participants rated consensus over the IPR as an important factor for the achievement of synergy in the consortia, while the rest described it as slightly important.

Table 25. Factors of Synergy Creation

Factors	Very Successful	Successful	slightly or not successful	Mean	Std.
Application and use of ICTs	70%	22,50%	7,50%	3,77	0,811
Bridging different group interests	57,50%	40%	2,50%	3,67	0,729
Commitment & devotion of partners	62,50%	35%	2,50%	3,62	0,9251
Confidence Security & trust	65,00%	30%	5%	3,72	0,7506
Consensus over IPR management	77.5%	22.5%	0%	3,97	0,6597
Convergence for longer-term cooperation	40,00%	50%	10%	3,65	0,7355
Efficient role of the Board of the consortium	90,00%	5%	5%	4,1	0,7089
Equity & balance between the partners	37,50%	50%	12,50%	3,3	0,8533
Funding and research stability	67,50%	12.5%	10%	3,77	0,8619
Similar objectives of partners-collective belief	60,00%	37,50%	2,50%	3,62	0,6279

5.2.1. Assessment of Magnet

This section elaborates on the supportive relationship between the impacts of innovation networks, Magnet's budget, and increases in the high-tech exports and patenting activities as to clarify innovation networks contribute more to the industrial and economic growth than the conventional methods.

Allocations of the Office of Chief Scientist R&D grants are realized on three main schemes: (i) adjustment of support rate or the eligibility criteria to meet the budget constraint; (ii) randomization; (iii) implementation of competitive, ranking system. The last option is typical to Magnet Program.

Projects need to be ranked, and the funds will be allocated from the top down until the Magnet budget is fully exhausted (Trajtenberg, 2000). It allocates a budget of 60 million $ -70 million $/ year on a competitive basis to the winning consortia. Magnet finances two third of the R&D budget of the consortia with straight grants, and there is no payback obligation.

Though a fair ranking system among the different fields of industrial activity is difficult to achieve, the OCS undertakes it efficiently. They do not apply standard criteria of primary sector or types of firms, but responds to the trends of market and industry. The dangers of parochial policies, the "picking of the winners" by government officials will be eliminated (Trajtenberg, 2000). This feature of Magnet is similar to the Triple Helix model's statement of evolutionary theory of selections, and the importance of industrial trends and market needs. Thus though Israel Government has industrial priorities, it follows an evolutionary and competitive way of selection rather than a fixed route to fixed case.

Magnet receives a central funding from government (ECTI, 2000; Sokolov, M., Verdoner, E.M., 1999). The government funds 66% of the approved budget of the Magnet programs. There are no royalty payments, and no additional governmental funding. The Magnet program is not allowed double governmental payment, thus any additional funding must be provided by the program participants. Magnet does not have an expected date of completion, or limited time duration hence government has not allocated any overall budget to the program.

By the end of 2001, there have been 21 consortia controlling a budget of $60 to $75 million (Trend Chart on Innovation 2000; Trajtenberg, 2000).

Table 26. Active MAGNET Consortia as of December 1999

1.	Algea Cultivation Biotechnology
2.	Broad-Wide Band Communications (BISDN)
3.	Consortium for Industrial Software Tools
4.	Digital Printing Consortium (DPI 2000+)
5.	Digital Wireless Communications
6.	Diode Pumped Lasers
7.	DNA markers
8.	Drug and kits Design and Development ("Daa't")
9.	Ground Stations for Satellite Communications
10.	Hybrid Seeds and Blossom Control
11.	Information Super High-Way in Space Consortium (ISIS)
12.	IZMEL
13.	Large Scale Rural Telecommunication Consortium
14.	Magnesium Technologies
15.	MMIC/GaAS Components
16.	Multi Chip Module (MCM)
17.	Multimedia Online Services
18.	Quarter-micron Technology Consortium
19.	Streaming Rich Media Messaging Consortium (STRIM)
20.	The Israeli Software Radio Consortium (ISWR)
21.	Wafer Fab Cluster Management Consortium (WFCM)

Source: www.consortia.magnet.org.il, SNI Annual Report, 2000.

Consortia are established for a period of up to five years and with an opportunity to extend the duration for an additional 12 months to complete the project. The User's Associations get 66% for the first three years and 50% for additional two years. The funding will not go past the pilot plant stage (ECTI, 2000). After then, any additional R&D for the actual commercialization of the products is not supported by the Magnet. However, member companies may apply for regular grants of the OCS. The Magnet program operates on a competitive basis; it is open to any number of proposals for the formation of new consortia, and it selects the projects for financing on a ranking system.

Table 27. The Office of Chief Scientist Budget 1988-2000

Year	R&D grants	Paybacks	Paybacks/ Grants	Net Grant	Magnet	Incubators
1988	120	8	0,07	112	NA	NA
1989	125	10	0,08	115	NA	NA
1990	136	14	0,1	122	NA	NA
1991	179	20	0,11	159	0,3	3,6
1992	199	25	0,13	174	3,7	16
1993	231	33	0,14	198	4,6	23
1994	316	42	0,13	274	10	28
1995	346	56	0,16	290	15	31
1996	348	79	0,23	269	36	30
1997	397	102	0,26	295	53	30
1998	400	117	0,29	283	61	30
1999	428	139	0,32	289	60	30
2000	395	128	0,32	267	70	30

Source: Trajtenberg, M. p. 15. 2000 (in 2000 $ million)

The total budget of the OCS increased steeply since 1988 till 1995, then increased slightly and has changed little since then. The budget of each the OCS programs increasing at almost at decreasing rates while the budget of Magnet shows a constant rise and even while those programs have shrinkage Magnet does not experience such reduction in its budget. This stable increase in the allocation of budget for Magnet and the doubling of budget in 1995-96 strengthen the importance of innovation networks and trust in the success of Magnet type of R&D funding. Besides these, though the other programs has started and continued with larger budget allocations, Magnet started at a lower budget but sheltering more companies and institutions than the other programs.

High-tech sector is considered as to be one of the indicators revealing the relation between the R&D expenditures and R&D inputs. In the view of the fact that most of the research grants are given to the high-tech companies, it is not unreasonable to assume that an increase in the OCS support programs corresponds to the increased Israeli high-tech exports of Israel. Then the steady increase in Magnet's budget (Table 27) may possibly correlate with increases in high-tech exports.

However, even if the research grants have gone to high-tech exporters, the sector is so divergent that the support budget is allocated in small firm shares. The disposal of grants for the same product via different firms could very well prevent the achievement of better R&D and innovation results. Therefore, instead of multitude of small research grants, Magnet type allocation schemes should be preferable especially to catch-up countries in terms of better allocation and utilization of national resources. Similarly, a sample study of World Zionist Organization in 2000 has shown that over a period of ten-years, 41 per cent of 1000 government-aided projects produced commercial products, while 26 per cent were successful in foreign markets. During the same period, Magnet funding has been increased as well.

Table 28. Israeli High-Tech Export

Year	High-tech Exports in $	% of High-tech share in exports	Rate of growth
1988	831,382	9,93	...
1989	998,353	10,69	20
1990	1,111,525	10,66	11
1991	1,170,933	11,26	5
1992	1,366,108	11,71	17
1993	1,609,098	11,99	18
1994	2,008,376	13,03	25
1995	2,719,332	16,03	35
1996	3,184,664	17,06	17
1997	3,844,893	18,56	21
1998	4,259,555	19,8	11

The patent and industrial R&D expenditures given in Table 29 shows that the number of patents barely increased during the 1987-1991 period, however the rate of increases was impressive during the 1991-1997 Trajtenberg (1999). This performance in the latter period can be explained with the increasing budget allocation to the Magnet program.

Table 29. Israeli Patents Registered in the USA

Year	Raw Applications	Patents issued, by application year	Rate of Success	Patents issued by Grant Year	Growth Rate	Industrial R&D
1987	503	295	0.59	244	27.7	550.3
1988	490	281	0.57	238	-4.7	423.2
1989	624	318	0.51	324	25.5	396.6
1990	608	325	0.53	298	2.2	468.6
1991	633	312	0.49	304	-4	510.7
1992	780	355	0.46	335	13.8	559.3
1993	803	421	0.52	314	18.6	574.7
1994	1,040	576	0.55	349	36.8	631.3
1995	1,072	613	0.57	384	6.4	614.4
1996	1,042	609	0.58	484	-0.7	668.6
1997	1,185	664	0.56	529	9	
1998				741		
total	12,962	7,013	0.54	6,432		5397.7

In light of the previous observations, it can be safely assumed that of the OCS support and the Magnet have produced more than the sum of their would-be individual outcomes. The OCS support programs have been very useful in encouraging innovation. However, the size of the Israeli industry is not big enough to compete against the background of emerging world trends. The Magnet program effectively renders the unification of resources for the multilateral commitment to an innovative positioning in world markets. Consequently, the unification of resources for the common goal of economic and industrial growth is a reliable way for Israel. Magnet has proved to be a unique approach to the Israeli economic and industrial development.

According to the recent evaluation report, there have been 12 consortia and controlling a budget of $60 to $75 million. In each consortium, at least 250 researchers work jointly in a suitable environment.

There are at least 63 scientific articles published, more than 30 patent applications made and more than 88 different products introduced because of the interaction between industry and academia. The establishment of several new companies was reported but the exact number was not available during the survey.

Due to the limited data acquisitions on patents and exports; the statistical analysis of the study cannot reveal much about the specified impacts of Magnet on the Israeli economy. However, the survey provides a presentation of the accomplishment of Magnet regarding the better optimization of R&D inputs and achievement of improved R&D outcomes as related to the participants' individual achievements shown in Table 30.

Table 30. The Widespread Impacts of Magnet

Factors	Very Successful	Successful	slightly or not successful	Mean	std.dev.
R&D inputs					
Eliminating the duplication of R&D inputs	50,00%	35,00%	15,00%	3,35	1,000
Decrease in R&D equipment costs	32,50%	35,00%	32,50%	2,95	1,060
Decrease in R&D personnel costs	32,50%	37,50%	30,00%	3,00	1,080
Decrease in the time-span for R&D / product introduction	47,50%	40,00%	12,00%	3,32	0,859

Table 30. continued

Factors	Very Successful	Successful	slightly or not successful	Mean	std.dev.
R&D outcomes					
Access to knowledge, edu. Reseach pools	77,50%	20,00%	2,50%	3,97	0,733
Access to state funds	80,00%	15,00%	5,00%	4,07	0,828
Allocation of resources other than R&D	35,00%	35,00%	30,00%	3,20	1,104
Assisting knowledge sharing & interacitve learning	52,50%	30,00%	17,50%	3,42	1,103
Contribution to higher education facilities	35,00%	32,50%	32,50%	3,02	0,919
Higher potential for firm\SME creation	27,50%	40,00%	32,50%	2,87	0,911
Improvements in human capital	47,50%	27,50%	25,00%	3,27	1,060
Improvements in R&D\ innovation capability & capacity	70,00%	17,50%	12,50%	3,70	0,853
Increase in the number of patents scientific papers	42,50%	30,00%	27,50%	3,15	0,923
Increase in the product quality	30,00%	35,00%	35,00%	2,95	0,904
Increase in the product variety	42,50%	42,50%	15,00%	3,30	0,757
Increasing research conditions in industry	73,50%	17,60%	8,80%	3,79	0,808
Increasing research conditions in university	59,00%	20,50%	20,50%	3,51	1,295
Increasing assessts for university	61,50%	23,10%	15,40%	3,61	1,269
Improvements in R&D results	77,50%	15,00%	7,50%	3,82	0,747
Reduction of costs & risks	67,50%	30,00%	2,50%	3,82	0,747
Speed-up commer. know.\ efficient technology transfer	57,50%	35,00%	7,50%	3,62	0,806

Regarding the R&D inputs, most of the participants stated the success of the Magnet Program in eliminating the duplication of R&D expenditures and decreasing the time for R&D and product introduction. Moreover, Table 30 strengthens the view of importance of outcomes of innovation activities as much as their direct outputs (Jaffe, 1999). Even though it is difficult to measure and differentiate the direct outputs of Magnet, the respondents found the Magnet program successful in accomplishment better R&D and innovation results, which are integral for the future interaction of society, economy, and science.

The participants' assessments of their achievements are quite revealing. As shown in Table 31, although a limited number of industrial firms stated they experienced a net change towards exporting, or patenting they stated they experienced becoming more cooperative; science oriented and to carry on the long-term process of research. Consequently, much less cultural differences between academia and industry will exist in the future programs. Such achievements strengthen the support for the Magnet program and networking as critical contribution to the Israeli research system. The long-term prospects for innovation-based competitiveness are taking over the immediate short-term expectations.

Table 31. Changes in the Company

Factors	Radical changes	Change	Slightly-or not changed	Mean	std.
Becoming more competitive	60,00%	37,50%	2,50%	3,62	0,628
Becoming more cooperative	55,00%	32,50%	12,50%	3,47	0,876
Becoming more export oriented	25,00%	42,50%	32,50%	2,40	1,236
Becoming more productive\ more output	75,80%	15,20%	9,10%	3,69	0,951
Becoming more science oriented	40,00%	35,00%	25,00%	3,07	1,022
Consent for longer-term research	57,50%	32,50%	10,00%	3,55	0,959

In light of these accomplishment and changes, the respondents were asked possibility of these impacts without participating in Magnet. According to Table 32, while a few of the respondents considered the possibility of this success even without the Magnet program, most of the respondents stated either definitely impossibility or impossibility of this success.

Table 32. Possibility of this Success Without Magnet

Definitely Impossible	Impossible	Possible	mean	std.
47,50%	35,00%	17,50%	3,45	0,959

As final remarks, the respondents stated the success of the Magnet program in meeting their expectations and reasons to participate.

Table 33. Success of Magnet in Meeting the Demands

Very successful.	Successful	Slightly -not successful	Mean	Std.Dev.
89,70%	5,10%	5,20%	4,07	0,928

Specifically according to Table 34, 96,5% of the industrial respondents stated they are fully satisfied, and the 61,1% of the academicians stated to be fully satisfied.

Table 34. Participants' Satisfaction from the Magnet Program

	full satisfaction	Satisfied	slightly-not satisfied	Mean	std.
Industrial Satisfaction	96,50%	0,00%	3,60%	4,21	0,629
Academic satisfaction	61,10%	38,90%	0%	3,77	0,732

Finally, the views of respondents on the re-participation is compared. As given in Table 35, the average of academicians and industrialists close to each other. Most of the participants are definitely willing to re-participate in the program.

Table 35. Participants' Desire for Re-participation

	Enthusiastic	Natural	Not eager	Mean	std.
Industrial Re-participation	96,80%	0,00%	4,20%	4,29	0,690
Academic re-participation	93,80%	6,30%	0,00%	4,50	0,632

5.2.2. Conclusion on the Empirical Research

The Magnet consortia are not end objectives themselves; rather they are designed to achieve further national scientific, technological innovations and industrial development. Moreover, instead of sole aim of increasing the individual income rates, Magnet provides the accomplishment of the expansion of national innovation and industrial capacity and capability. Magnet is the efficient and effective pooling as well as allocation of Israeli national resources for industrial and socio-economic welfare. In light of 10 dimensions that are derived from the comparative analysis and theories of Triple Helix innovation networks; Magnet reveals an exceptional success in terms of carrying out the features of the Triple Helix model. It performs relatively greater success in terms of synergy creation first at the domestic level, second among the highly innovative European Countries and finally among the big economies of selected OECD countries. It is indisputable that Israel achieved this success by the exclusive role of Magnet; however, Magnet is an exemplary program in Israel innovation system. Magnet is initiated, based on and now is operating according to the principles of Triple Helix.

First, Israel has been transformed from socialist economies to market economies and recently to knowledge-based economies. Secondly, there has been a trend from military R&D to civilian R&D. Israel has achieved both of these transitions smoothly through the application of market-friendly R&D programs and policies. Magnet is a market-friendly program, which is based on competitive selection and equal participation of both university and industry. Knowledge-based economy requires the internalization of knowledge creation into a system of multiple players. The R&D and innovation activities are subjected to the conflict, competition and consensus among the consortia participants. Magnet endogenizes knowledge generation and knowledge sharing into the consortia. This interactive learning and mutual feedback render a non-linear, multifarious innovation system. All of the participants are informed about the latest scientific & technological developments in their fields, and all of them are cognizant of the research process. Third after the initial knowledge sharing and interactive learning, each partner has become able to develop, produce and commercialize their own unique product and or process. This provides the system with dynamism and positive/creative competition among the consortium as well. Moreover, it prevents technological monopolization and limitation of innovated product variety.

The fourth point is as an ideal Triple Helix model states magnet is not a total obscuration of institutional boundaries. The consortia are designed as larger virtual bodies to complement each of the players' roles and to undertake multiple roles rather than squeezing the activities into one setting and make the SMEs or academy become a sub-contractor to a larger participant. Moreover, in Magnet Committee the participation and representation of all of the concerned parties are actualized on equity, none of the parties is subordinated to the others. Indeed the organizations of consortia are also actualized on this basic principle of equal participation and representation.

CHAPTER 6

6. IMPLICATIONS FOR TURKEY

6.1.1. International Trends and Turkey

The literature and the case studies confirm that today there is increasing cooperation between industry and academy in the industrialized world as well as in newly industrializing countries (NICs) of Latin America and East Asia.[13] However, still in industrializing countries like Turkey, the academia and industry relations are apparently far from adequate level. Technology transfer is preferred to technology development. In this section, Turkey's S&T innovation dynamics and ongoing programs and policies are briefly presented to figure out the applicability of good innovation network practices that have been derived in the previous section.

It is useful to disseminate and apply the lessons learned in developed country cases and specifically Magnet for the drawing up an innovation network measure for Turkey. While in their general design the features are similar to each other, networks should be tailored according to the specific needs of Turkey. In the long run the model will be reflected as the features of national innovation system for strengthening research, education, technology and industrial level of Turkey and its international cooperation.

The Israeli Magnet Program represents a flawless measure for innovation networks. It can be said to represent almost the best practice in network development. Therefore, it will not be wrong for Turkey to make a recursive modeling using the Israeli Magnet Program as a learning process. On the other hand, though Israel and Turkey have common motivations and some similar aspects, they are diverging on a number of conditions from international relations to domestic dynamics; the main differences are based on economic size and capacity. In fact, Turkey's innovation capacity has a lower level than most of the countries, which are lagging effective policy practices.

This policy formulation does not endeavor to address the national innovation system completely; but rather it aims to draw a customized network framework for Turkey, which brings a common understanding for innovation between two countries. Subsequently, this recursive modeling between Israel and Turkey leads to a common innovation network structuring that renders innovation corridor between two countries, especially on the grounds for the attainment of the upcoming S&T and innovation arrangements between Israel and Turkey as well as for the improvement of bilateral relations. Israel's more favorable position with respect to integration to and compatibility with the European Union S&T and innovation policies make Magnet Program a rational prototype for Turkey to base its broad national innovation system. The recursive modeling of Israel paves the way for Turkey for the integration to European Research Area.

6.1.2. Turkey's ST&I Dynamics

Before analysis of the pertinence of good policy practices and of Magnet Model in Turkish context, the institutional settings, recent rules and regulations on the way to improve R&D capacity through university-industry cooperation and the reasons behind the lagging of Turkey are dicussed. Although the reasons are gathered from Bozkurt and Aytac's "Study of University-Industry Cooperation in Turkey: Bursa Example, 1999", it may not be sufficient as a regional study that reflects only a partial picture of Turkey. However, against this criticism, the

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[13]For further information on Latin America and East Asia, see Sutz, 1999 and Wade, 1999 respectively.

Bursa case remarkably reflects that in the absence of a comprehensive framework neither the number of variety of firms and industry nor the existence of an academic institution is sufficient condition for effective university industry cooperation.

Turkey, which inherited the belatedness of the Ottoman Empire in science and technology, is expending intensive efforts both to close this gap and to catch up with the changes of the new age. R&D expenditure in Turkey in 1997 was 915 million US dollars and the ratio of expenses to the Gross Domestic Product (GDP) was 0.49 percent. The higher education sector leads in research and development expenditure, realized at 57.2 percent, followed by the commercial sector at 32.3 percent and the public sector at 10.5 percent. If it is taken into consideration that R&D expenditure of the industrialized countries is around 2 to 2.5 percent of their GDPs, then it cannot be said that a sufficient financial source has been allocated for this objective. Therefore, the lack of sufficient sources for R&D is the reason behind belatedness of Turkey for innovativeness.

Turkey has been ranked at a lower position in terms of university-industry, 36^{th,} and industry-university cooperation, 39th, in World Competitive Handbook 1999 list. (Dodgson, 1999). Moreover, overall R&D activities are weaker than those of NICs. As a comparison, Korean per capita income is 3 times that of Turkey, whereas its R&D expenditures are almost 30 times that of Turkey (Lalkaka 1999 in World Bank 1992). Clearly, Turkey does not possess the capacity for strong R&D activity. Nevertheless it is observed that important advances have been made in Turkey in recent years as to the number of international publications. The number of publications originating from Turkey in the periodicals in the Science Citation Index was 361 in 1981 and this figure increased to 5,109 in 1998. Turkey's rank on the world list that was 42 in 1981, ascended to 25th place in 1998.

6.1.3. Institutional Settings of Turkey

6.1.3.1. Research Organizations

A notable feature of Turkish S&T system is its well established organizational framework. The most important development in the field of science and research was the establishment of the Scientific and Technical Research Council of Turkey (TÜBİTAK) in 1963 during the transition to the planned economy period in the 1960s. It is considered as a main governmental body for the management of S&T and innovation policies in Turkey. The objective of TÜBİTAK is to develop, encourage, organize and coordinate research and development activities in the fields of basic and applied sciences. TÜBİTAK, as an institution, which has administrative and financial autonomy. The main TÜBİTAK roles are:

1) To provide consultancy to the government for the determination of policies on science and technology;
2) To provide financial support for research and development activities undertaken by the universities, the public sector and the private sector.
3) To carry out the secretariat services of the Supreme Board of Science and Technology;
4) To give scholarships and awards with the objective of supporting scientists and researchers;
5) To provide information services and to publish scientific publications.

Together with the State Planning Organization, TÜBİTAK funds most of the R&D in higher education through some 800 projects. TÜBİTAK also supports industrial R&D, an activity that absorbs about 10% of its R&D funding (industry pays the salaries). The funding for university R&D involves equipment, space, consumables, travel, salaries of auxiliary personnel, and scholarships.
In 1983, the Supreme Board of Science and Technology was established reporting to the Prime Ministry. This was formed an important step for the

determination, direction and coordination of the research and development policies in Turkey. The Supreme Board of Science and Technology is the organ that determines the highest-level policies in the Turkish science and technology system. It is composed of the related ministers and the representatives of the related organizations under the chairmanship of the Prime Minister (Iste Turkiye, 2000).

The main services of the Supreme Board are:
To assist the Government for the determination of the long-term science and technology policies;

1) To determine of research and development goals;
2) To determine the priority fields for research and development;
3) To appoint the research and development organizations in accordance with the research and development plans and programs (Iste Turkiye, 2000)

The establishment of the Turkish Academy of Sciences (TÜBA) and the Turkish Patent Institute in 1993 are important developments in the 1990s. TÜBA, which has been established with the aim of improving the scientific research standards in Turkey to the international level, is connected to the Prime Ministry. It has a juristic personality, which has scientific, administrative and financial autonomy. This institution, supporting youth towards scientific and research subjects and awards those who expend efforts in these fields.

As a complementary organization, TTGV/TTDF was established on June 1, 1991 in order to improve the industrial sector's awareness of R&D and to support technology development projects of the Turkish Industry through the funds provided by Undersecretary of Treasury from the resources of the World Bank.
TTGV is an independent, non-governmental, non-profit organization established jointly by the private and public sectors. TTGV has a special status that has undertaken a national mission of fostering the continuous and effective

technology development activities of companies in the industrial sector. It is an open, transparent organization that is accessible and presents a minimum of red tape and bureaucratic procedures. It has a proven track record that demonstrates the success of its support for the projects of industrial sector companies, and it has proven its international credibility through its representation of Turkey at TAFTIE, a grouping of European organizations involved in similar activities.

In addition to these decision-making umbrella bodies, there are a number of public research institutions namely:

- The Chairmanship of Refik Saydam Public Health Center;
- The General Directorate of Mineral Exploration and Research (MTA);
- TUBITAK Information Technologies and Electronic Research Institute (BILTEN)
- TUBITAK Defense Industry Research and Development Institute (SAGE)[14].

The Marmara Research Center (MAM), one of the research and development units connected to TUBITAK, continues research activities with approximately 400 researchers at its facilities, constructed on a large area in Gebze.

A very broad spectrum of research and development activities are undertaken at the center, established in 1972, including geological sciences, genetic engineering and biotechnology, electronics and cryptology, information technologies, space sciences and technologies, materials and chemical technologies, food science and technologies, environment and energy systems.

- Ankara Nuclear Research and Education Center (ANAEM),
- Cekmece Nuclear Research and Education Center (CNAEM)
- Lalahan Animal Health Nuclear Research Institute.

There are units connected to the Turkish Atomic Energy Commission are operating for research, development, application and education activities in the nuclear field.

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[14] They are two smaller scale R&D units of TUBITAK

Besides these, TUBITAK also provides some technological facilities. The main units providing these facilities are the National Metrology Institute, TUBITAK National Observatory, the National Academic Network and Data Center and the Instrumental Analysis Laboratory in Ankara. There are 64 research organizations in Turkey, where more than 1,000 researchers work in the fields of developing agriculture, forestry and aquaculture under different state ministries.

6.1.3.2. Higher Education Institutions

In addition to these governmental bodies, Turkey has a large number of higher education institutions. Institutions of higher education consist of universities, faculties, institutes, higher education institutions, conservatories, vocational high schools and application research centers. The first university reform was realized in 1933 with the contributions of Jewish scientists who came to Turkey to escape on Nazi Germany. The objective of this reform which went into effect with Law No. 2252, was to enhance the activities of education, training, science, and research to a contemporary level. This law is accepted as the beginning of the scientific activities and science education in its modern perception in Turkey. The Darulfunun was closed within this framework and transformed into Istanbul University. This was followed by the establishment of other modern universities (Iste Turkiye, 2000).

As of 2000, there are 553 faculties, 200 higher education institutions, 251 institutes and 475 vocational higher education institutions are giving higher education in Turkey. Even though many of the higher education institutes are not accredited at the international level, Turkey has many other high capacity technical universities, such as Middle East Technical University, Istanbul Technical University, Izmir High Technology Institute, Aegean University, Bosphorus University, as well as highly qualified medical and clinical universities Hacettepe and Istanbul Universities. In addition to these state universities, several big corporations in Turkey have instituted their higher education institutes namely KOC University, Sabanci University, Bilgi University, Atilim University, Kultur University, and Kadir Has University. The increasing number of private universities reflects the need and support of private sector to higher education. Previously, Turkish industry initiated several technical vocational high-schools in order to meet the technician needs of their factories; now it is time for the researchers and engineers. During the 1998-1999 school year a total of 1,464,740 students, including the Open University students have received education at higher education institutions and a total of 20,608 teaching staff have worked in these institutions. The number of students receiving education abroad with official scholarships, with the objective of educating teaching staff for the universities is 1,016 with 40 at bachelor's degree level and 976 at master or doctorate degree levels (Iste Turkiye, 2000).

The Turkish academia is modeled after the 19th century Western tradition of basic research and education. It has not yet adopted the recent changes (2nd Academic Revolution) that have been experienced in the Western academic scene. As late as 1990, government regulations have impeded interaction; faculty members were not allowed to work for industry. However, the recent law on Technology Development Zones (2001) allows academicians to work in private enterprises located in these zones. As teaching is the main function of professors, they are engaged in courses so much that they are not able to conduct research for industry.

Masters and PhD studies are not generally geared to meet the industrial needs. Courses of study are not related to practical application and hence the graduates are not qualified with industrial requirements (Bozkurt and Aytac, 1999).

6.1.3.3. Turkish Industry

The Turkish industry has emerged out of the ruins of the Ottoman Empire, which was lacked of the three main requirements of industrialization: ‘finance (money), technology, and manpower (human resources)’ (Tugcu, 2000). From the foundation of modern Turkey until today, the Turkish industry passed through several stages of development. The period between 1950s and 1960s is described as ‘Assembly Industry Phase’ when most of the industrial establishments were obtained from abroad. They were performed an assembly operation before marketing domestically. The next period between 1970s and 1980s is described as the ‘Licensed Industry Phase’ when the necessary parts and materials were obtained from abroad and the technology related to the manufacturing operations and complete products were supplied through licensing agreements. During this period limited number of products was produced due to license agreement constraints. The final phase is the ‘Global Industry Phase’ between 1990s and 2000s, when original products and product technologies are designed, developed and exported by national industry (Tugcu, 2000).

During the foundation years of the republic, the first initiation came from the Turkish state to establish the industry, as there is no private capital to initiate business. Although this initiation was welcomed for industrialization and it gave impetus for industrialization, since then, the Turkish Private Sector have not been qualified to achieve the competitiveness at the global level. Most of the domestic companies in Turkey is still in the phase of assembly industries or perform manufacturing with licensed technologies.

Turkish industry is composed of several big family corporations, and smaller business enterprises. The Turkish industry has gained a limited export capacity as a result of technology transfer, foreign investment and cheap labor, but this is not enough to compete with at the global level. Most of the industrial activities are still based on 1960s and 70s technological processes, thus to be competitive the industry urgently needs to start use of new technology as much as possible.

Recently due to the establishment of several technoparks and KOSGEB, the number of SMEs and high-tech start-ups, which are considered as the main motors of knowledge-based economy, are on the rise. SMEs are mainly focussed on high-tech and greatly in need of new technological knowledge. Most of the Turkish industry is in need of high technology, but they are not able to tackle with the high cost of and risks of R&D activities. Significantly, they are in need of knowledge and R&D personnel sharing. Apparently, as these companies start to share knowledge and R&D costs and risks through a successful networking system, they will become more innovative and increase their exports, thus the economic welfare of Turkey will improve.

6.1.3.4. Human Resources

Relative to its huge population of more than sixty million people, the researchers of Turkey are not demonstrating a good level. The total number of full-time equivalent researchers working in the higher education, public and commercial sectors in Turkey was 23,432 as of 1997. Of these researchers, 57.3 percent work in higher education, 24 percent in the commercial sector and 18.7 percent in the public sector. However, the main relative advantage of Turkey over those countries is its young and dynamic population that is becoming more research oriented, entrepreneurial minded and demanding to start its business.

6.1.3.5. Legal Measures

The first initiation for university-industry relations was the initiation of the ‘program of Revolving Funds’. It was introduced in 1981 by Turkish Higher Education Law. It is simply a contract between faculty and the industry. Each university controls its Revolving Fund which is the income coming from industry (Lalkaka 1990 in World Bank Report 1992). However, the system has not worked as efficiently as planned. Since mid of 1990s some more policy steps for university-industry networking have been taken, as a result of the pressures of globalization, attempts for the harmonization of policies with EU and for the utilization of the benefits of knowledge-based economy. Some important legal arrangements have been introduced on the protection of intellectual property rights. Decrees having the force of law (DHFL) were promulgated concerning the protection of patent rights, industrial designs, geographical signs and brands.

In addition, a decree has been promulgated in 1995 that envisages state assistance to the research and development projects carried out by industrial organizations. This decree provides extensive opportunities to industrial organizations engaged in R&D activities; around 50 percent of the expenses for R&D projects can be paid by the state without being repaid. For the rest of 50 percent, the industrial organization can obtain financial support and repay this amount on its real value if it succeeds in commercializing the product it develops.

At the meeting of the 'Turkish Science and Technology Policy 1993-2003' under the auspices of the Supreme Board of Science and Technology on February 3rd 1993. The following points have been identified for future S&T policy framework:

1) To increase the number of full time equivalent researchers that are now seven per capita for the economically active population to 15 per capita;
2) To increase research and development expenditure from 0.33 percent to 1 percent;
3) To increase the rank of Turkey from 40th place to 30th place in the world list from the aspect of the contributions to universal science;
4) To increase the share of the private sector in the total research and development activities from 18 percent to 30 percent.

These are further developed into “Project for the Significant Advancement of Science and Technology” within the scope of the Basic Structural Change Projects envisaged to be taken up with priority by the Supreme Planning Board in the Seventh Five Year Development Plan Period (Iste Turkiye, 2000). The Project for the Significant Advancement of Science and Technology shows the direction of transforming Turkey into a country, which can produce science and technology and can transform them into economic and social benefits.

The main points of this framework are:

1) To establish the National Information Network that will make Turkey knowledge based society;
2) To adapt flexible mode production and flexible automation technologies;
3) To focus on industrial development in aeronautics and space technologies and defense industry;
4) To increase R&D activities in bio-technology, genetic engineering and national venture projects;
5) To increase environment friendly, energy saving technologies.

As a part of these goals in 1990s Turkey began establishing technoparks (World Bank, 1992 Report). Currently ODTU (Middle East Technical University), ITU (Istanbul Technical University), EGE (Agean University), MRC (Marmara Research Center) and TEKSEB (Technology Free Zones) technoparks are undertaking these functions:

1) Business incubator for small high-tech start-ups,
2) Channel for commercialization of technical know-how of universities,
3) Attractive sites for the in-house R&D operations of larger corporations (Oppenhaim, 1992 in World Bank, 1992 Report).

In addition to these, Uccan (1990) stated technoparks provide training in marketing, finance, and work as means for industry to access the facilities of academia such as libraries, computers and laboratories. Beside structural and functional problems of technoparks, the research of Lalkaka and Schiff (1990) on developed countries' technoparks showed that: A technology park requires two or three decades to reach full potential and involve millions of dollars of investment (World Bank, 1992). Therefore, unlike the other mechanisms such as networks and hybrid settings between university and industry, technoparks takes much longer time to take shape and develop full operational capacity. As they cannot bring about the expectations in a short time period and require larger expenditures, it would be more viable for Turkey to initiate framework programs that are composed of industry and university.

Although Industrial Partnership Program (IPP) is not as comprehensive as the developed country cases, it is designed for the sharing of the knowledge, technological results and infrastructure of TÜBİTAK-MRC with the Turkish industry. It aims to engender competitive economic structure and export improvement through development of R&D facilities, and knowledge sharing between industrial applicants and MRC. IPP does not envisage the establishment of pre-competitive R&D consortium among the industrial partners or as well as with academia. It is designed as an individual-based program to benefit from the resources of TÜBİTAK-MRC.

6.2.1. The University-Industry-Government Relations in Turkey

Consequently, though a number of legal instruments are introduced for the expedition of R&D activities, they have not brought about the expected results and especially achieving synergy among the actors of economy. They have either insufficient participation or resources but extensively they have been subjected to the political instabilities and left in the pilot stages. The reasons behind this experience are illustrated with the research of Bozkurt and Aytac (1998) among industrialists and academic staff in Bursa.

According to the results of this survey, industrialists[15] are found to be hardly cooperating with university especially during new product development.

- The Reasons For Non-cooperation

41% of industrialists stated that they did not need cooperation, 20% expressed that university facilities (laboratories, personnel, and libraries) are inadequate and 36% pointed out they had no information about what universities are doing at all.

- Views of Industrialists who Cooperated with the Universities

On the other hand the 68% of industrialists who cooperated with the universities stated that it was very beneficial, 23% of them stated they got little benefits, only 9% found it not beneficiary at all.

- Academic View On the Industrial Cooperation

78% of academicians[16] expressed that they experienced cooperation with industry. The frequency of cooperation is distributed as follows 40% sometimes, 36% seldom and 24% frequently. The cooperation topics were as follows; 56% technical, 24% educational, 12% administrative and 8% financial. However, there is no exact mention or tendency for R&D cooperation, which is the main focus of university industry relations in developed country cases.

According to the view of academicians, 50% of the problems that they experienced during cooperation process is based on the "introvert character of industry as well as the economic and physical deficiencies of the partners" (Bozkurt and Aytac, 1998, p.5).

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[15]Total number of industrialists is 100: 18% are employers, 33% are chief executive officers, 49% are assistant general managers or department heads. 80% are university, 14% are high school, 4% primary school and 2% are secondary school graduates.
[16] Total number of academicians is 32 appointed proffesors. 44% from Administrative Sciences, 22% Engineering and Architecture, 19% Science & Literature, 15% from Agricultural Faculties

60% of the academicians prefer individual cooperation in order to evade the high-cuts realized on behalf of university, while the 40% were affiliated to cooperation on an institutional level.

57% of non-cooperating academicians stated that they have received no invitation/demand from the industry; 29% of them expressed that they had no desire for cooperation, and 14% of them pointed out lack of time for cooperation because of high academic tutorial load. It reflects the necessary change in the role of university as well.

- Reasons behind these observed patterns

1. Structure of Universities: Turkish higher education was modeled on western tradition; however it has not been amended according to recent changes in western universities. Universities are limited mostly to basic research and teaching and they do not have a motivation or support to develop new capacities (Bozkurt and Aytac, 1999). There are big differences in facilities and equipment between the ten older universities in and around Ankara and Istanbul and the new ones recently established throughout the country.

   The older universities and the private ones are reasonably well equipped and have laboratories able to carry out R&D activities. On the other hand, while most of the new universities have personnel with PhD degrees and some research experience, they do not have laboratories in which experimental development can be carried out.

2. On the other hand, there is a lack of confidence towards universities among the industrialists. Negative employment experiences led them to conclude universities' curriculums do not address industrial needs and practical education. Unfamiliarity of industrialists on the research subjects and terminology of academicians, as well as capricious behaviors of

academicians are claimed to impede cooperation (Bozkurt and Aytac, 1999).

3. Some of the industrialists argue that it is better to transfer knowledge from abroad instead of putting effort into cooperation with universities which are to be "30 years behind the industry…with inferior library acquisitions in countries like Iran or Saudi Arabia" (Bozkurt & Aytac 1998, p.3).
4. Structure of Industry: Family dominant, small sized structures of industries prevent the modernization of organization and production methods. Intensification on end products for domestic markets suppresses the need for obtaining technology. As there is insufficient competition among the local industries, there is little desire to upgrade technology. Most of them have common prejudices against academicians.
5. The Context: Turkish government, which has a highly bureaucratized structure for R&D can not assist either industry or university to become competitive at the global markets. The university industry networks are strived to be undertaken in a context of undefined roles and relations. Additionally because of the insufficiency of communication channels or cooperation frameworks partners are not willing to come together and work collectively.

Turkish industrialists have disinclination to invest and cooperate in R&D on account of the lack of public expenditure and investment in R&D. If the Turkish industrialists continue to think R&D activities would cost so high and they would not get any government or university support or subsidy, they would not invest in R&D. Moreover, macro economic, political instabilities and the failure of long-range strategic management cause partners not to invest for longer-time and high risky projects like R&D activities (TÜBİTAK, 1995).

There is a disbelief in the importance of cooperation and lack of confidence among the potential partners. As a result, both sides accuse the other as being ignorant and unable to first step. In regard to these issues, the absence of the facilitating environment for university-industry network in Turkey, networking has remained on a very limited scale with some exceptional cases. This insufficiency induces the danger of widening gap between academic research and technology applications while non-cooperation causes industry not to utilize the existing qualified human capital.

Bozkurt and Aytac (1998), concluded, "as long as the sides fail to form a networking approach, it would not be possible to realize the desired leap that industry dreams of, or to regenerate and acquire the dynamism that university is starved of" (p.6). However, it is concluded from the literature on innovation networks that anticipating either university or industry to initiate such programs is not a correct policy comprehension, but just the loss of time and resources. Thus the governments are required to correct the systemic failures and initiate and administrate such measures.

6.2.2. Innovation Network Framework for Turkey

Despite the unfavorable picture for innovation networks, Turkey has still some key advantages to develop and implement innovation networks polices on the grounds of Turkish: (i) young and hard-working population; (ii) increasing interest in technology and entrepreneurship; (iii) high social adaptation. Moreover, Turkey to some extent has the experience and skills for foreign markets; additionally it has enough domestic market potential and government procurement capacity. Furthermore, it has the socio-economic conditions that expedite the dissemination of new technologies and its association with the existing technologies. The case study on Bursa demonstrates the lack of a governmental framework is the reason behind the unawareness of economic actors about each other's potency and insufficiency of innovation networks.

6.2.2.1. New Role for Turkish Government

Contrary to the common belief of non-intervention in the economy, the government of Turkey evidently needs to intervene and direct the industrial affairs. This policy should not be considered as a challenge of liberalization, deregulation and privatization policies that have been undertaken since 1980s.

Turkish Gross Domestic Product (GDP) and Gross Expenditure on R&D (GERD) are disproportionately lower than the average of the OECD and most of the other developing countries. The first objective of the government should be to increase its own expenditure on R&D (GOVERD) and also encourage industry to increase business expenditure on R&D (BERD and thus the GERD will increase. Though Israel has a lesser amount of GDP than the selected countries, it has the greatest GERD share.

In order to have a strong GERD base the country does not need high a GDP; the critical point is the determination of priorities and thus allocation of resources according to this priority. The Turkish government and the industry must give priority to the R&D investments.

Unlike most of the developed countries, Israel has been suffering from constant political problems and high economic burden of military expenditure, however it does not impede Israel to invest in R&D. On the contrary as Israel has been aware of the importance of R&D for its national security and welfare, its share is greater than the other countries. Thus having political problems cannot be used as pretext for having less GERD; conversely lesser GERD would exacerbate the situation. Analogously while in the smaller countries the main argument is the 'creation of critical mass of six or five million people', within the context of Turkey the argument should be the 'creation of critical mass of two and half million dollars of R&D'.

At first off, even if government or industry cannot increase the R&D spending, the government needs to fund the 60% to 80% of the anticipated program and the rest should be undertaken by the participant industry. This is repeatedly emphasized by the consortium members that without the government support these big projects cannot be undertaken or completed by solely industrialists. As the case study indicates neither the overall budget nor the amount of the program is important in the design or for the success of the program, unequivocally a stable budget allocation per year is important for the success of the program. Inevitably the cost of higher education and research institutes need to be financed by the government as well. In case the involvement of foundation (private) universities are anticipated, their participation cost should be financed by own budgets or their industrial connections are encouraged to participate.

6.2.2.2. Academy and Industry

While the academic culture versus industrial needs evolve around intellectual property rights regime in the developed country cases, in Turkey they have not even been able to respond to each other's needs.

In the first place, universities need to reshape their curriculum concerning the needs of industry without jeopardizing the future needs of basic science and higher education. Universities need to obtain information about industry's existing, potential and future technological demands. Reasonably, the Triple Helix model also suggests latecomers to design a new entrepreneurial university or restructure of existing ones according to the MIT prototype. Therefore, if the government wishes to have competitive universities conducting their own R&D programs to promote research and train graduate students, the present limited number of universities (10-12) with good research facilities funded can satisfactorily carry out applied research and experimental development at international level, while the rest limit their activities to undergraduate teaching.

The majority of Turkey's researchers are in higher education, but the salaries are too low to encourage R&D activities further. Academic promotion is heavily based on basic research and scientific papers and there is turn down to devote time for applied research (Bozkurt and Aytac, 1999). For this reason, the authorities responsible for S&T are considering not only salary increases but also the possibility of measures to encourage university professors to co-operate with industrial enterprises to develop new technologies and products.

Second, there must be a feedback mechanism between industry and academia that enables both sides to be informed about the existing developments. Industry must be encouraged to interact with universities and employ more new technology. University-industry interaction should focus on preparing and updating the skills of R&D personnel, and learning to work for the co-development of technology and technology transfer (Zagottis,D., 1989 in World Bank Report, 1999).

Within the university-industry network approach industrial participant (competitive firms, contractors, big or small) should also be required to work with other industrial participants.

Subsequently any of them can produce and sell its product. They need to consider national competitiveness more important than the individual losses and gains at the first stages. The culture and mentality of both industrialists and academicians should be modified from shortsighted individual profit maximization to the achievement of synergy for the sake of national and societal welfare.

6.2.2.3. The Intermediary Organization

Turkey has a diverse system of S&T and several institutions; however, in contrast to the general tendencies, these bodies lack absolute political power to make decisive policies. Instead of forming a new body, the Supreme Board of Science Technology should be granted an exclusive responsibility in the initiation, funding and management of the anticipated the program. Turkey has been suffering from the delays and cessation due to hierarchical bureaucratic system. The role should not be diversified into other sub-bodies as to prevent the cross standing and funding. Moreover, rather than a research organization, it should be a political body that is credible and reliable and should have enforcement authority over the participants. This state body needs to initiate the anticipated program between university, industry and government. It needs to have the capacity to bring all of them to work cooperatively.

This program should have administrative autonomy. The representatives of the industry, university and government should be allowed to contribute to the management of the program. As long as these people are allowed to manage the system, they will not be alienated from their jobs and they will commit themselves to the core of the work. Not only in view of non-cooperation between Turkish industry and academia, but also for the better coordination of the participants, in each of the project there should be a coordinator for academic and industrial relations within itself as well as vis-à-vis each other and vis-à-vis the government.

6.2.2.4. Objectives of the Anticipated Program

Clarification of the program objectives according to the national capacity is the main issue. However, under the prevailing circumstances in Turkey, it is really difficult to define the national capacities and priorities. Especially important is the shadowing of medium to long-term actions by short-term political considerations; thus the R&D policies or the upcoming framework should be protected from being subjected to the political instabilities. Although Turkish science and technology priorities are regularly reviewed by TÜBİTAK; these polices do not receive political support and base.

Policy advising for Turkey would include the creation of a high-tech sector in the areas that are more suitable for the current capabilities and thus require less capital investment as a start. TUBITAK identified the R&D priority areas regarding the general trends in the world. However, instead of such restrictive approaches the R&D potential of Turkey should be examined first. However, a comprehensive analysis of national S&T and innovation capacity and foresight study requires money and time; therefore, it is not easily obtainable under the time and budgetary constraints that Turkey is facing. As a remedy to this, the capacity of universities and research centers, which are easier to be analyzed can be used for the design of the national innovation priorities. Second, the research areas that have the potential of international cooperation, with abundant skilled researchers as well as promising competitiveness should be identified and given priority in the design of national innovation system.

Turkey need to define much more focused innovation fields according to its national capacities. Such as in the areas of bio-technology and genetics, Turkey has relatively better research laboratories, promising university departments and staff. Additionally, the researches in this area seem to cost less, have less risk than space, aero-technical or nuclear energy fields.

Moreover, Turkey may focus on projects on alternative energy resources or information technologies. Thus the capacity of knowledge producers should be decisive, even the technical universities can be empowered to set the research agenda. Furthermore, though the examined cases and Magnet are open to any interested party, Turkish program may apply a positive preferential policy in favor of high capacity technical universities in leading and deciding the agenda of research thereafter the national institutional settings can be utilized completely.

Indispensably, due to Turkey’s high population of semi-skilled people, as well as its intensification in medium/low-tech sectors such as, textile, consumer electronics, white goods, and automotive can also be revitalized with the application of new technologies. On account of this policy, the citizens' general welfare and economic security would increase, which subsequently will provide an opportunity to allocate resources into other high-tech sectors as well. One of the academic participants of Magnesium Consortium highlights such a case, as this consortium is dealing not in high-tech matters of computers electronics or bio-technology, but rather in the production of a bicycle, a briefcase or fenders, which are all innovative for their markets.

Undoubtedly, Turkey cannot simply copy the main trends or 'best policy practice' of industrialized countries because of its domestic constraints; it needs to customize the general trends according to its capabilities and capacities. However while following this customization, strengthening the critical mass of existing high-tech sectors, regions, and actors, developing the innovation capacity of other sectors should also be balanced. A focus on a traditional sector should not be considered against the program, the aim should be to produce technologically innovative goods.

While an existing partnership between industry and academia is an asset, the it is misguided to wait for the partners to get involved in the program; but rather it is more applicable to arrange the partnership under the umbrella of the measure. The eligibility criteria for the projects should be reshaped according to changing circumstances; however the main points should be the economic benefits, commercial potential, technological innovation and active cooperation.

6.2.2.5. Program Procedure

Turkey has been establishing several programs for the industrial development; however, most of the programs have not been successful, and they have been aborted or even they have not progressed from the pilot stage into a concrete solution. These have been mainly affected by the design of the program, which causes implementation problems later on. The new program needs to be designed to secure the commitment and trust of the participants. The participants should not be left individual and become alienated from the project. The program must be designed as teamwork of industrialists and academicians. Regular meetings must be organized between them for the exchange and sharing of knowledge as well as improvement of trust between them. At each stage results must be reported and saved on computerized data systems and be accessible to all partners. Each project financially supports the computerization of data storage.

The budget of the program must be stable, the government and industrialists need to continue the guaranteed amount of support even if there are other macro-economic instabilities. In Turkey, projects are mostly granted without well-calculated time spans for the realization. However, this causes the projects to be fruitless with an increasing financial burden on the government. In order to prevent ineffectiveness, the projects must have strict time duration. The 5 years plus 1 year extension formula of Magnet is a viable method to be utilized by Turkey.

As participation places a financial burden on the industrialist, only financially strong or big companies can participate in the programs. This creates an unfair advantage for them to utilize governmental and academic resources. Although the newcomers or dissemination of knowledge outside the group may cause shrinkage in the shares of the present stakeholders, technology dissemination and new members should be encouraged and facilitated.

Even if it is not deniable that each project has unique dynamics and should have a customized management, for the framework for management of intellectual property rights, and the dissemination of knowledge outside the consortia, Magnet IPR regime should be taken as a model. It is too early to leave the management of IPR in the hands of project group since they may not be effective in dealing with such a complicated issue and may jeopardize the harmony of the group from the beginning.

The project managers or coordinators have to be responsible for submitting regular reports to inform the government about the progress or problems of the program. All stakeholders need to be held responsible for the success or the failure of the project, and they should be accountable against public since project budget is partially funded from governmental resources.

The governmental body (Supreme Board of Science & Technology) needs to assess the projects according to the reports and reviews of the external examiners. The interim reports between the start and end of programs should examine how much the projects have covered the planned stages. If there are delays, the causes need to be managed swiftly. The final progress report, on the other hand, should examine the results of the program in terms of achieving the proposed technological innovation, economic advantages, improvement in export, and acceleration in the product introduction into the market.

It might be difficult to identify or to achieve the desired technical and economic output right away.

However, the real success measure of the program depends on the development of linkages and synergy between universities and industry, which has subsequent benefits both to the participants, and to the country. On that account, Turkish Program should focus on how much trust, cooperation have been achieved between its members. In addition, the success in the better optimization of R&D inputs such as expenditure, human capital and technical equipment and elimination of the duplication of the R&D inputs by different members should be considered as a success indicator.

6.2.2.6. The Main Lesson for Turkey

Even though the Turkish context demonstrates unfavorable conditions for the university, industry and government relations because of distrust and legal and cultural barriers between industry and university, it has the potential to form rewarding university-industry-government relations. The main question for Turkey is to initiate a cultural change; for the establishment of an innovation system Turkey needs to have an innovation culture before anything else. The new setting has to institute trust, reliance, cooperation and interdependence, assure the commitment of each participant to the system free of individual loss-win considerations.

In response to the question on the assessment of large participation and new comers as a challenge to their stakes, the vice president of one of the company's in the Magnesium Consortium frankly emphasized 'we need knowledge either from industry or academy, it does not matter it will increase knowledge accumulation and opens new dimension and mode of thought'. Additionally, when the opinions of one academician about consortium has been asked, he stressed the importance of participating in the Magnesium Consortium for the university and national economy, he stated that neither industry nor academy has the luxury to ignore one other and work apart.

Therefore, beyond all these structural considerations of budget, funding, IPR regime, projects or sectors eligibility criteria; the anticipated program for Turkey needs to establish the values of 21st century mode of production among industry and academy.

6.3.1. Readiness for Inter/Multi National Collaboration

In this section, some of the indicators and guidelines for successful international cooperation analogous to the Triple Helix based UGI relations are identified. This helps the elimination of the dichotomy between technology producers (developed countries) and technology users (developing countries). It will help Turkey to become a part of global production system as well. While the level of economic development, ideological similarities are used to be factors for the collaboration between states, recently the culture and philosophies for the management and generation of innovation becomes another important determinant of international cooperation. Beyond the percentages of GERD or total number of researchers, currently different indicators have been utilized as to measure the readiness for international cooperation in R&D and innovation programs. These indicators are assessed from a comparative perspective on the general indicators derived from innovation programs in developed countries (see Chapter IV.3) and the University-Government and Industry (UGI) relations in Turkey.

6.3.1.1. Governmental Indicator: 'An active participant government'

As international cooperation starts at the governmental or institutional levels, a developed country (S&T body) seeks out the facilitator bodies that operate on similar basis. Successful country cases and Israel reveal the existence of administrations by which science base and productive base are integrated.

They have absolutely identified ST&I bodies that are dedicated to the management of UGI relations. Thus, after having an administrative reform and restructuring the S&T bodies Turkey will become a more eligible partner for cooperation.

6.3.1.2. Academic Indicator: 'Entrepreneurial University'

The existence of a highly qualified academic culture and the rise of entrepreneurial academia with the mission of economic development are the general indicators to initiate encouraging relations between university and industry. However, it would be barely credible to have attainable relation between a university with a number of independent interdisciplinary centers, and programs where the staff following the latest developments, and a university where faculty assumes basic research and education on traditional areas as its exclusive mission and cannot follow the recent scientific developments. Therefore, as a second point, Turkey needs to reform its higher education system to become not only to be more industry-oriented universities but also to become internationally attractive higher education institutions.

6.3.1.3. Industrial Indicator: ‘Science-based industry’

A significant number of technology-based industries that have the ability to integrate internal R&D, production and commercialization process with external partners are the preferable business types of knowledge-based economy. Therefore, in order to be an eligible partner in international programs, Turkey urgently needs to initiate a framework that encourages its industry to generate technological innovation via networking and partnership.

6.3.1.4. Work Force: ‘Skilled human resources’

Well-educated human resources that are capable of developing and implementing innovation are critical national assets attracting other nations for cooperation. For instance, Israel has highly qualified human resources who can find positions at the international research groups. Turkey on the other hand with its younger and educated society demonstrates some advantages as to make cooperation since most of these countries are suffering from ageing/ elderly population and declining birth rates.

6.3.1.5. Stability of the Program

The financial and political stability of the program, are more positive indicators than the amount of R&D expenditure for a successful cooperation. Additionally, if Turkey cannot expand its GERD, Turkey needs to convince the international participants about the stability and commitment to the measure. Innovation policy must be immune from the short-term political and interest considerations. It must be embedded into the national system and culture.

6.3.1.6. Well-defined Market: 'Rich consumers'

All of these programs are aimed at producing goods that have the potential for commercialization; they may have even existing markets. The forecasts of future consumer trends and needs decrease the risks of marketing. Moreover, existence of sufficient market pull with increasing demands for the application of technology in the products is also important incentives for collaboration. While with its large young and demanding population Turkey represents a good market, the low income rates and life standards are shrinking the purchasing power, and people are forced to consume less technology intensive products. Therefore, Turkey also needs to increase average income level, as indicated in the previous sections.

The literature survey and the case studies reveal the mechanisms of innovation networks, more specifically the Triple Helix system works on an evolutionary selection mechanism enacted by its members. In this system there is no central control dictating them what to do or not. Since the participants are linked through the elements of trust, cooperation and close interaction, they prefer to select those with whom they can achieve these elements and have mutual benefit. Thus, while they have the inclination to select the ones, with whom they can form a beneficial partnership, they have disinclination to cooperate with the ones who does not carry the characteristics that are defined as indicators for collaboration.

Historically, while capitalist liberal economies used to cooperate between themselves, communist socialist states used to form their networks. Currently, studies reveal that cross-cutting arrangements like the Triple Helix are becoming the mode of cooperation. Thus it is not illogical to assume the foundation of cooperation between countries now have the characteristics of Triple Helix in their innovation or more generally in their production system. International networking can be successfully achieved among states whose R&D programs are designed on similar base and whose potential partners not only seek the opportunities to gain, but also contribute to the system.

For instance, Israel demonstrates a favorable position on the way to integrate to international R&D programs on the grounds of its (i) similar mode of industrial production; (ii) propitious industrial, academic and human capacity; (iii) persistency to participate in EU framework programs, and other international linkages. On the other hand, Turkey with its younger population, big market size, its commitment for development and integration to EU as well as Western values may eventually become a highly promising partner.

The aim of international cooperation is to co-development of technology rather than establishment of multinational companies or transfer of technology from one company to another.

Analogous to national level, international cooperation aims the pooling of multinational resources either industrial, academic or human resources. The aim is also similar endogenization of knowledge production into the system and reduction of technology transfer costs and applicability risks of new technology products. On the other hand, not only developing countries are in need of cooperation, but also developed world needs cooperation since even if they can generate innovation endlessly, they will not be able to find innovation demanding young and rich consumers to sell their products. As a case to the point while Finland is considered the center of ICTs and cellular phones, the consumers of cellular phones are mainly from developing countries with their larger population.

6.3.2. Turkey-Israel Relations

Turkey and Israel are two important countries in the Mediterranean and Middle East Region for the prosperity and stability of the region. They are both participating in the EU program for the Mediterranean Nations Cooperation program. Numerically, Israel has twice the human resources of Turkey (in full time equivalent) in a country that is ten times smaller. This is the only country in the region, which has 140 R&D personnel per 1000 workers like France or Germany. Israel outstandingly demonstrates successful R&D performance in total. Cooperation with Israel at the regional level stimulates interactive learning of innovation management not only for Turkey but also this interaction is likely to spill over to other countries which in the long run would lead to peace and welfare in the region.

Recently, industrial, academic and government participants from Turkey and Israel have been initiating several cooperation programs. One of the private universities of Turkey Sabanci University and Gebze Industrial Zone are in cooperation with Israel's TEFEN Industrial Park.

This initiation aims to launch a similar technopark in Turkey in collaboration with additional Turkish industrial and trade chambers and organizational industrial zones. Indeed, a similar project between TEFEN and another Turkish university and industrialists had been negotiated previously. However due to the different priorities, different understanding for industrial development as well as budgetary fluctuations and constraints originating from especially Turkish side impeded the establishment of anticipated program.

When the opinions of the economic advisor to the TEFEN were asked about the coming program, he frankly stated: 'Turkey has a time consuming bureaucracy and political instabilities that made everything slow, while in Israel the time is considered like an ice-cube, and everything is utilized to be expeditious.' A second problem he underlined is while Israel has a more entrepreneurial-minded society who invests in production, Turkish people were reluctant to invest due to the instabilities and especially for investments in high-tech. A critical point he mentioned is the differences in the understanding of the necessity of the application of technology in industrial development that caused the cancellation of the previous program. Nevertheless, he underlined TEFEN is more hopeful in this recent agreement between Sabanci University, since he considered Sabanci University to be a more industry oriented and entrepreneurial university and thus to be more reliable and relevant partner.

Moreover, the active participation of Turkish state to support program with the 10 years tax exemption regulation for the companies that participate in this common project made this second venture more hopeful for. (Ha'aretz, 2001).

Another proposed program is Qualified Industrial Zones (QIZ) between Israel the USA and Turkey. Technically the QIZ are a US-Israeli arrangement, but the US decided to bring Turkey into this framework within 2002.

An undersecretariat official said after the meeting that the prevailing atmosphere had been "positive" and that the US was due to begin procedures to establish a QIZ in Turkey. The US side also urged Turkey to begin contacts with Israel to move the matter forward. However, in order to be an active partner to the technology produced in these agreements, Turkish industry, academy and human resources need to be enabled to produce mutually with their partners. (Hurriyet, 2002).

Turkey needs to achieve progress on several critical points regarding these programs as to be successful and eligible in further cooperation programs:

1) A stable macro-economic environment that encourages both domestic and external investment,

2) Stability in government subsidies and programs for R&D,
3) Technology demanding, using and generating industry,
4) Universities with multi disciplinary subjects on basic and applied research,
5) Continuous human development.

CHAPTER 7

7. SUMMARY AND CONCLUSION

7.1. Conclusion and Policy Implications

This dissertation presents a comparative analysis of national innovation networking programs with a special reference to the Israeli Magnet program. In this regard, it tries to identify the main indicators for the formation of successful national and multinational innovation programs. The theoretical framework for the analysis is built on the arguments of Triple Helix modeled university, industry and government relations. The study presents the science, technology and innovation policies in paradigmatic shifts stating the basis of their initiation.

The literature survey shows that Triple Helix principles should be taken as the main paradigm in formulating a propitious university, industry and government cooperation in order to grasp the benefits of knowledge-based economy. In the light of the literature survey and case studies, the study re-emphasizes the features of knowledge-based economy in respect to the following points:

First, countries witness evolutionary changes in the role of government, academy and industry. Triple Helix model redefines the roles of business, higher education, government and other institutions and provide a starting point for creative public-private sector relations. The government has become an active participant of industrial affairs and stimulates interaction between academia and industry. While the university conducts more industry-based science, industry has become more science-based.

Industrial affairs of a country do not depend only on the role of industry. It requires important innovation linkages or networks in terms of technology, skills, information, marketing and customer needs, which are incremental in competitiveness and to direction and pace of innovation. Second, the programs that portray as much as the characteristics of Triple Helix can be considered as successful models. The success of the networks depends on the collective belief and the creation of synergy between the participants. Synergy of the group can be supplied from the trust, security and commitment of the partners.

Moreover, stability of the programs are significantly important for the achievement of the program objectives and hence success as well. Both the stability and the synergy of the programs can be achieved through active participation of government for the synchronization of the relations between participants. Science, technology and innovation policies are not enough; they must be integrated into the whole system and must be in coherence and consistency with the general economic, social and defense policies. Governments must be the initiator and organizer of such frameworks and provide the necessary, stable regulatory setting for the academy and industry to work together.

Good policy practices do not necessitate large budgets, but rather the existence of a stable political system and government funding for long-term R&D programs, a favorable macro-economic environment, and constant supply of knowledge and human capital render successful innovation networks.

Rigidities in the academia, research centers or industries on the way to innovation networks should be corrected, and improve responsiveness to economic and social needs. The critical point for developed countries is that these countries cannot tolerate the conditions in unstable, poor and technology-lacking countries since they need stable technology demanding international markets.

Besides, the forces of globalization are forcing everything around the world to become interdependent. This fact is realized with the initiation of several EU funded programs for Eastern Europe or Mediterranean regions. These industrialized countries need to share their experiences with the late comers. The main lesson for developing countries is not to copy or proceed with a reflexive modeling of the best practices, but to identify their own objectives, strengths and weakness and make a recursive modeling according to their potential.

Furthermore, concerning the cross-national relations, regional or international innovation networks are said to replace multinational companies (MNCs). As long as these programs carry out the same tendencies and principles, they will have a mutual cognition for innovation and thus initiation of wider common projects and programs between them will be eased. While it is easier to have networks between developed countries, in case the catch-up countries are successful in customizing the main objectives of Triple Helix, they may become favorable partners for international cooperation with the developed world.

Endogenization of knowledge production into networking systems provides efficiency in the resource allocation and reduces the risks of duplication, transaction costs at the national and international levels.

While the establishment of national innovation networks provides the optimization of national resources and eliminates the dichotomy between the 'upstream technology producers academy' and users 'industries'; the establishment of multinational innovation networks eliminates the dichotomy between the 'upstream technology producers developed countries' and 'users developing countries'. As states think, organize and produce from the similar perspectives, national differences and boundaries will be eliminated and they will contribute international welfare and progress.

In light of above conclusions the study has received and expanded to the general theme of Triple Helix model which centered on the importance of ' breaking boundaries building bridges' not only at the national contexts but also at the multinational levels. On the other hand consumer relations, market pull for the successful adaptation of technology and traditional organizational structure of companies versus increasing flexibility and should be considered further points to be examined.

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APPENDICES

APPENDIX A

A. Conceptual Framework for Performance Measurement

Table A.1. Conceptual Framework for Performance Measurement

Concepts	Correlates	Proxies
Inputs		
Persons\years------------	expenditures	
Equipment\years--------		
Outputs		
Ideas, discoveries----------	papers, prizes, patents	
Inventions----------------	disclosures	
Human capital-----------	degrees awarded	
Technology transfer------------	CRADAs, licences---	cost shared dollars
Outcomes\ or impacts		
Broad advance of human---------	papers, citations	
Knowledge---------------------	expert evolutions	
New products --------------------	patent citations------	licences, licences
		Royalties product
		Announcements new product sales
Productivity improvements ------	productivity growth	
Income growth -----	benefit/cost ratio or rate of return—	new firms,
		Induced investment
Excitement-interest in Science------	new articles	
Health, environment, etc------	new drugs------	emissions
Cooperation and knowledge flow-----	CRADAs………	

APPENDIX B

B. The Country Studies on Innovation Networking Measures

B.1. Denmark

In Denmark, company clustering has been on the policy agenda for along time. The aim of the government policy is the promotion of organizational innovation. It aimed to increase the percentage from 20 % to 50% of companies applying for innovation and more flexible organizational models within few years. Assuredly while Denmark is more successful in the company-company relations 5th it is rated 10th in case of company-university relations according to WCH, 1999. In order to extend the latter point, Danish government, launched a recent program called: Regional Growth Centers.

Regional Growth Centers

The objective of the centers is to further co-operation on technology, market development and organizational issues among companies and knowledge institutions in areas with strong local business competencies.

The centers will be organized as consortia, comprising at least one knowledge institution (typically a 'GTS' Approved Technology institutes) and one educational institution. The consortia apply for funding in relation to the establishment and operation of the center. The consortium, in co-operation with companies and other local stakeholders, sets up a steering committee responsible for the broad development of the centers

The role of the government is to fund and catalyze the measure, and render interactions between its target group SMEs/ Industrial SMEs Research Institutes Public Authorities/Organizations.

Eligibility:

The Growth centers are formed as a consortium. At least one of the members will have to be a local educational institution, and at lest one must be a knowledge institution (typically a GTS institute).

Financing:

The contribution to the centers is maximum 60 per cent of its total budget. For general activities the contribution can be up to 100 per cent, and for activities directed at companies the contribution can be not more than 50 per cent. General activities must not exceed 20 per cent of total costs.

Overall budget allocated to the measure Euro 6 million. Expenditure per year 2001: 2 million; 2002 and 2003: each year 2.7 million. Additional Financing can be obtained from other budgetary sources, moreover local trade and business and local authorities must contribute at least 40 per cent.

Even tough the program has just started and there are no unequivocal indicators of success, EU trend chart reporters stated that the establishments of consortia are at least proves its success.

Competence Center Contract Programs

Danish Center Contract is another scheme funding collaborative research to form a bridge between companies and latest research results of the universities. While it aims to strengthen the industry-oriented capabilities of research institutes, it renders industry to perform more innovation projects. It aims to promote strategic innovation project in cooperation between companies, research and technological service institutes to ensure more innovation in companies, higher interaction between industry and academia and higher competence and market orientation in the technological services.

Danish Government initiated, investing and catalyzing interaction between large companies or SMEs and industrial or non-industrial companies, research institutes, and universities. The team must be made up of at least four firms and a university department. They need to have a Approved Technology Institute (GTS) which is responsible to bridge academia and industry. Partners can participate without having to fund R&D but they need to fund their own expenses. New partners are always welcomed while developing the full proposal.

The program is a legally binding agreement between the partners for the accomplishment of a developed project. The projects are selected on the basis of solving a concrete development requirement in the developing companies. Additionally, it must build up a commercial know-how with participants transferable to other firms. The selection committee is composed of industrialists, researchers, and representatives from the public sector. They assess the capability of program to lead to industrial take-up and particularly they look for the provision of any potential industrial demand as a result of the research accomplished by the center contract.

Accepted projects are often split into subprojects, this facilitates the management and renders it to be dealt with from a wide variety of aspects. In terms of technology diffusion they experienced frequent mobility of human capital at the technical representative level, and a number of annual meetings and subproject meetings are carried out to expedite knowledge exchange. Those who worked in the projects hold intellectual property rights.

The financing is realized on yearly basis.

1995: Euro 6 million	1996: Euro 12 million
1997: Euro12 million	1998: Euro 10 million
1999: Euro13 million	2000: Euro 13 million

Additional financing is available from Ministry of Research and Information Technology: Euro 8 million for 1997-2000, and Euro 3 million. Implications & results of the program has not completely evaluated, however the current formation of 10 more contract centers and expected increase in the market competitiveness considered as the success of the measure. Moreover, the cooperation between companies, universities and technological service institutes is reported to be incremental for further innovation.

B.2. Finland

Finland is now rated to be one of the most competitive country in the world. This is due to its efficient innovation policy that focussed on R&D expenditure and knowledge-based economy initiatives (Tekes, 2002). Tekes is the major national actor in implementing technology and innovation policies. In many respects as it is leading country in innovation design and implementation. Indeed in WCH list, Finland is ranked 1st both in company-university and company-company cooperation. As to keep its position it uniquely and continuously designed its innovation policies.

The close cooperation between industry, research centers, and research organizations and universities are considered as a special strength of Finnish system. The cluster programs have been operation since 1996 (European Commission Report, 2000). The most notable measure is the Center of Expertise Program. It is a regional initiative scheme concerning the establishment of framework conditions conducive to innovation. Though Finland initiated many programs this study examines CoE program as relevant tool for university-industry-government relations.

Tekes Centers of Expertise Program

The aim is to enhance regional competitiveness and to increase the number of high-tech products, companies and jobs. To achieve this goal, the programme will be used to implement projects reflecting the needs of industry, to encourage industry, research and training sectors to co-operate, to ensure rapid transfer of the latest knowledge and know-how to companies and to exploit local creativity and innovation.

The role of the government is as catalyser and co-ordinator of the program. The measure receives central funding from the government. The target groups of the program are Large Companies/Large Industrial Companies SMEs/ Industrial SMEs Research Institutes Universities Public Authorities/ Organisations.

At national level the co-ordination is arranged by the Committee. It is composed of members representing industry, research, Regional Councils, cities and the State administration. The Committee serves as an advisory board to the ministries involved in all matters concerning the Program. At regional level programs are implemented in co-operation with local actors in form of specific projects that are coordinated mostly by the regional technology centers.

Financing is done by a seed-money for the catalyst action. The allocation is based on the annual report and action plan made by each center. These reports and plans evaluated by the Committee for the Center of Expertise Program. Financing is allocated to various Centers in accordance with a proposal of Committee, and in 1999-2000 four ministries together are funding this basic operation. Tekes' funding is targeted at projects which produce new know-how, bear high technological and commercial risks, and in which the impact of Tekes' funding is substantial. The projects are selected using criteria based on Tekes' mission statement. The projects to be funded promote sustainable competitiveness, commercialisation of research results, and emergence of new business activities. They increase the internationalisation of companies and research activities, and networking of partners.

In 1994-1998 Total Budget is Euro 12 million. In 1994-1998 Euro 2,2 million per year and in 1999-2006 Euro 5 million per year is estimated (ECTI, Finland Country Report, 2001). Additional funding can be available in terms of industrial co-funding, from the National Technology Agency of Finland, cities and municipalities, EU funding and universities (ECTI, 2001).

The results and impacts of the program are observed in the direction of increased regional co-operation and networks, new companies and jobs. According to the unofficial survey (1999) the Centers of Expertise have contributed to the increase of 8,500 new jobs and 290 new high-tech firms in 1994-1998. At the same time, the number of projects has increased and it is now five times bigger than in 1994. At the present the seed-money is a share of the total funding of the Programs total project volume is only about 5 %, which indicates that the original concept of the Program works in practice (ECTI, Finland Report, 2000).

The seed money has been considered as an effective catalyst for local action. Common features explaining the successful operations are having a full-time coordinator, strong links and commitment to the regional development strategy, and long experience of co-operation between the partners.

The same concept has now also been applied to other new initiatives. Scope of these new programs (the Urban Development Program and the Regional Center Development Program) is larger than in the Center of Expertise Program, which is focused on top excellence. This reapplication implicitly proves the success of the measure. However according to the official evaluation, industry had not participated as fully as hoped during the first program.

B.3.Ireland

Ireland has experienced a rapid growth during 90s. The growth of High-Tech sector, regional innovation models, nurturing of SMEs and attracting of foreign companies especially from the US for investment are the main factors of Irish rapid development (Roper and Frenkel, 2000). On the other side, there has been an ongoing criticism of the weaker position of national industry against foreign investments, and there have been demands of developing the domestic industry (Roper and Frenkel, 2000). Indeed recent Foresight study and the National Development Plan emphasized the success and competitiveness of Irish industry can be achieved by the realization of a resonant RTD capacity on the strategic technologies that and on the effective management of the innovation process (Tekes Report, 2001). They state the research in universities, institutes have to be translated into marketable innovations and thus greater wealth can be generated for social, economic as well as further RTD needs.

For the effective management of innovations ICSTI recommends: The Department of Enterprise, Trade & Employment and its agencies should develop a national mechanism in the area of Innovation Management that would support companies, universities, colleges and research institutes in the commercialization of their research. Thus the vision of Ireland as a knowledge-based society has been described as the partnership of education, industry, government and society. Indeed Ireland reached this conclusion as a result of a very comprehensive foresight study. Under the light of these developments, Office of Science & Technology, Department of Enterprise, Trade, & Employment and Forfas initiated several programs. Enterprise Ireland is one of the best policy framework in leading Ireland as 9th and 17th in the university-company and company-company cooperation (WCH, 1999 in Dodgson 2000).

Against this background, the total 2,5 billion Euro for the whole science & technology and innovation are is distributed as follows:

698 million Euro to third level education to strengthen graduate engineering programs and the links between industry and education;

711 million Euro to a new foresight Fund to strengthen basic research in biotechnology and ICT areas;

484 million Euro to support R&D in industry;

267 million Euro to promote collaborative networks between colleges, research institutes and industry;

250 million Euro to targeted research programs to agriculture, fisheries and environment (ETCI, Ireland Country Report, 2000).

Enterprise Ireland combines other national resources and helps to build technological R&D capabilities and links between third level colleges and industry. They administer and promote national and EU supports to achieve networking. It has a variety of support tools and in order to be more effective they are offering customized services according to the needs of industry and research institutes rather than big standard policies.

The industry programs include support for high quality R&D in areas such as product development and innovation, process development and innovation, R&D management training and technology acquisition. Third level colleges are supported for activities such as basic and strategic research, scholarships, campus companies and collaboration with industry. Programs in Advanced Technology harness campus expertise to create new industrial opportunities and solutions. For this end they provide supports for R&D Projects & Networks, Post-Graduate Training & Development, Industrial Innovation, Creating New Businesses, Programs in Advanced technology, developing new business.

Innovation Partnerships

This program aims to stimulate new product and process development for industry through collaboration with Third Level Colleges resulting in mutually beneficial co-operation and interaction. Under this program, Enterprise Ireland will assist companies in their collaborative research with Colleges by co-funding the College research costs. Project proposals must demonstrate a clear benefit to the participating company(s) Applications may be submitted at any time and are subject to commercial and technical evaluation. Eligible applications are presented to the National Research Support Fund Board for approval on a monthly basis. Small companies and companies located outside Dublin are particularly encouraged to participate in the program.

Research Innovation Fund

The second program, Research Innovation Fund aims to support research ideas with commercial potential that arise from researchers/potential entrepreneurs within the third level academic community. The fund will support projects with commercial potential put forward by researchers in the Third level sector. Researchers may hold permanent or temporary posts but where the applicant has a temporary contract the project must be supported by a permanent member of staff who undertakes to complete the work in the case that the proposer is unable to do so (ECTI, Ireland Country Report, 2000).

The aim of the fund is to bring projects to the point where the commercial potential is demonstrable. It is anticipated that successful projects will be at the stage where further development will be in the form of commercial activity as opposed to further research. Commercial activity could include the setting up of start-up companies or licensing agreements etc. The scheme is conducted under the authority of the National Research Support Fund Board (NRSFB), a sub-board of the Enterprise Ireland Board.
This Board is comprised of representatives of third level education bodies, industry, appropriate Government Departments, Enterprise Ireland and Forfas. It was established to bring greater transparency to the allocation of research funds.

Advanced Technologies Research Program

Programs in Advanced technology are further programs for innovation networking. (PATs) are partnerships between Enterprise Ireland, industry and third level colleges. They were established to meet a need for a strategic expertise base in certain key technologies. They help industry to, access new technology; improve the competitiveness of existing production; move into new higher value areas. They also assist industry in attracting overseas and domestic investment in high technology areas that lead to the establishment of new technology based start-up companies.

Particular encouragement is given to projects that address the priority areas specified in a call for proposals. However, proposals may also be submitted outside these areas if they otherwise meet the objectives of the program in terms of generating technologies, products or processes on which new start-up companies could be based, or which improve industrial competitiveness.

The program is fully open on an equal basis to all full-time researchers in the third-level sector and non-profit research agencies/organizations. Staff on fixed term contracts are eligible, provided the term of the contract extends for the duration of the project. The contractual arrangement for the funding of the project will be between Enterprise Ireland and the host institution. For this reason, proposals must have the endorsement of the host institution at the time of submission.

Collaboration is encouraged where the experience and expertise of two or more institutions are expected to bring significant added value through a project result that would not otherwise have been possible. However, Enterprise Ireland will require each collaborating institution to enter into individual contractual arrangement for to carry out their part of the project. In addition, the collaborators will be required to enter into an agreement between themselves to bind them mutually to the terms of the standard project contract.

One condition of funding is that the researchers and the host institution accept that the primary purpose of the program is to generate applied research results with potential for exploitation in Ireland. In consequence, the protection of intellectual property and/or the ability to exploit the results must not be prejudiced by publication or other disclosure. However, Enterprise Ireland recognizes that publication of results is a normal and reasonable aspiration for researchers. It therefore, use its best endeavors to ensure that are reasonable balance is maintained between the need to protect IP and the desire to publish.

Under normal circumstances the ownership of intellectual property arising from the research will reside with the host institution. However, a feature of the program is that Enterprise Ireland and the institution will work together to manage the protection of intellectual property with commercial potential, and separate funding will be available for this purpose. Enterprise Ireland, will also, in consultation with the host institution and the researchers, take a proactive role in the exploitation of the technologies arising from the projects.

The proposals are evaluated on the basis of leading to technologies that: “have the potential to provide the basis of a start-up company; may be of commercial interest to existing industries in Ireland.” Second if they are transferable by means of license or other practical arrangement. Third, if they address specific current or emerging opportunities or threats facing individual sectors of industry in Ireland.

Proposals will be evaluated through a two-stage process. The first stage will be to determine their technical merit (originality and novelty of approach, feasibility, likely outputs, credibility of the project work plan, etc.). Those reaching an acceptably high standard of technical merit will then be evaluated and ranked on the basis of commercial potential (i.e. start-ups, transfer to existing industry, or development to address sectoral threats or opportunities). This ranking will be taken into account when reaching a final decision on the projects to be funded.

"Normally 25% of the grant will be paid on signing of the contract. Further payment of the grant will be made in installments specified in an annex to the contract and subject to the satisfactory progress of the project in terms of deliverables and milestones reached. An amount of 10% of the grant will be retained for payment at the end of the project, subject to all obligations with respect to final deliverables being satisfactorily completed" (Enterprise in Ireland, 2002). All funded projects will be subject to financial and technical audit at the discretion of Enterprise Ireland and/or any other competent authority. The host institution is obliged to maintain appropriate financial, administrative and scientific records to enable any such audits to be carried out.

In terms of the impacts of these programs, the report on the evaluation of innovation trends in Ireland states that, the networks are designed first to promote and support co-operation between colleges and firms in the short to medium term exploitation of research. Second to develop an industry driven agenda to direct these networks; and third to create scale in research groups of strategic importance to firms in Ireland. Hence by and large these programs contribute and intensify a number of schemes and activities of research, technology and innovation collaboration for Irish industry.

B.4.Netherlands

The Netherlands innovation system is composed of several governmental ministries at the top level and several Sector Councils and Consultative Committees as intermediaries between research institutes, universities, private firms. Though it seems complicated and divergent, the intermediary bodies operate along the lines and wishes of government and prevent the inefficient use of money by cross financing. Indeed Netherlands has been ranked 4th and 11th in company-university and company-company cooperation respectively. In Netherlands, networking is a key element of innovation policy. Public sector both offering strategic information and bringing participants on various platforms but also stimulating networking between partners by procurement policies. Netherlands initiated mainly seven measures directed for cooperation, however is the most relevant policy measure within the scope of this comparative analysis.

Business Oriented Technological Co-operation

This measure is a general subsidy scheme to support technological co-operation in the area of research and development. Strengthening company research, co-operation research/universities/companies. The target groups are the SMEs/Industrial SMEs Research Institutes Universities. The main role of the government is funding the program.

Projects are assessed and ranked on the basis of the criteria co-operation, technological innovation and economic perspective, and the importance of the project to the Dutch economy. The projects that match the criteria best receive funding until the budget has been depleted.

To apply for funding the following criteria apply: submission of a project plan and a budget plus clarification. The application has to be submitted (also on behalf of the other participants) by one applicant, the secretary. The secretary should be a company. The application should be accompanied by a signed agreement in which the co-operation or outsourcing is settled.

The project should be carried out by:

Partnership (of at least two partners, at least one of which is a company) that carries out a co-operation project at shared cost and risk.

A company that carries out the project at its own cost and risk and outsource part of the research or development activities to third parties.

The applicant(s) should have sufficient technical and financial capacity to carry out the project properly. It ought to be possible to carry out the project within 4 years. The project should be technically and economically feasible. The project should have sufficient positive impact on the Dutch economy.

Financing:

The overall budget allocated for the measure is not available. For 2001 a total of 50 million is available for two tender rounds, distributed as follows:

International technological co-operation projects: 6.4 million;

Emerging market co-operation projects: Euro 2.7 million;

Maritime co-operation projects: Euro 2.3 million;

ICT-breakthrough projects: 11.4 million;

Generic technological co-operation projects: 27 million.

Cumulating with other public funding or funding from the EU is allowed up to the maxima. A co-operation project is eligible for funding by Ministry of Economic Affairs only once.

Technological Cooperation Program

The BIT program has been recently prolonged by Technological Cooperation Program. It aims to support R&D interaction, strengthen the university industry interaction and company research facilities. This program receives a central funding and covers the nation wide R&D activities. Government predominantly plays the role of funder.

The target groups of the program are SMEs, universities, research institutes and industrial enterprises.

The criteria to be eligible to the programs are the level and intensity of technological cooperation, economic importance and feasibility of the project. Additionally, the applicant should have sufficient technical and financial capacity, and needs to carry out the project within 4 years. The project should be carried out by:

A partnership of companies, and knowledge institutes (at least one of which is a company) that carries out a co-operation project at shared cost and risk. The partners may be Dutch or foreign.
A company that carries out the project at its own cost and risk and outsources part of the research or development activities to third parties.
The Technological Co-operation is composed of a generic part and the specific areas international co-operation (under the EUREKA program), like co-operation with emerging markets, co-operation within the maritime sector and co-operation in the area of ICT-breakthrough projects (ETCI, 2000). The accepted projects are granted with a 50% government funding. Still additional funding on a limited amount can be applicable in case the project involves in those three above areas. However, a cooperation project is eligible to receive funding from the Ministry of Economic Affairs only once.

For the financing of 2001 a total of Euro 50 million is allocated for two tender rounds, it is distributed as follows:
'International technological co-operation projects: Euro 6.4 million;
Emerging market co-operation projects: Euro 2.7 million;
Maritime co-operation projects: Euro 2.3 million;
ICT-breakthrough projects: Euro 11.4 million;
Generic technological co-operation projects: Euro 27 million' (ETCI, 2000).

The net results of this program has not published or measured yet, however, the dynamic continuation of the system and evolving of one successful institutional setting into another can be implicitly considered as to ensue in success.

Overall Netherlands innovation system contributes to the economic and industrial growth of Netherlands. Roelant and Den Hertog (1999) stated that in Netherlands networking initially served mainly as to provide strategic advice on how to improve competitiveness and enhance knowledge flows. Recently they serve as important tools at the macro level to prevent the mismatch between science and industry and at the micro level they prescribe governments to focus on systemic failures.

B.5.Norway

Norway has a strong science and technology base. It has moderately good positions both in university-company cooperation (14^{th}) and company-company cooperation (15^{th}) (WCH, in Dodgson 1999). Norwegian Government initiated several measures for this framework. The public oriented programs are to strengthen the collaboration between firms and universities, colleges and R&D institutes such as FORNY, TEFT, SME-Competence, Reginn, SME-Colleges, and BUNT. These illustrate the shift towards demand driven technology diffusion models to interactive innovation systems, as in the case of most OECD countries (OECD, 1999). As cases to the comparative study Bridge and its recently independent FORNY, TEFT programs are examined.

Bridge

The fundamental concept underlying the BRIDGE-program is to bridge the gap between companies with little R&D activity and R&D centers, encouraging them to develop long-term relationships and specific collaboration projects.

The BRIDGE-program is intended to formulate and test measures that can help break down the barriers between these parties. The BRIDGE-program activities are to act as a catalyst for such processes, as well as to encourage the R&D centers to adopt practical working methods and dissemination strategies better suited to the needs of SMEs. To be able to offer companies relevant means to accomplish these objectives, the BRIDGE-program is also responsible for helping to establish a dialogue with business and industry per se – and with their organizations. However, further development of the means at hand depends on companies' response to this initiative.

To offer companies a more comprehensive development plan, in the years ahead, the program will give priority to strengthening strategic and operative collaboration with other public sector programs - especially the Norwegian State Industrial and Regional Development Fund (SND) and the government advisory and supervisory system in Norway and abroad. In many cases, links with international innovation systems will also be of the essence in keeping business and industry up-to-date on new technology.

In this context, technology and knowledge transfer involves the following. First recognition of the need to combine the ``hard'' and ``soft'' aspects of technology transfer. Second recognition of the need to combine tacit knowledge and formal qualifications. Moreover, technology transfers became as a commercialization of research-based ideas. As well as active, reciprocal communication processes and concrete projects between companies and R&D centers, based on dialogue and trust. Finally, Technology transfer is realized at the international, national and regional levels.

The total budget allocated for the measure per year is as follows:

1999: Euro 10.7 million

2000: Euro 7.7 million, excluding FORNY

2001: Euro 6.8 million, excluding FORNY.

It was not mentioned about the possibility or impossibility of additional financing.

Implications\ Results of the program:

There has been no overall evaluation of the BRIDGE program. Parts of BRIDGE have been evaluated, but not in 1999. In 1999 BRIDGE started 335 projects out of which 331 were targeted towards SMEs, in various branches of industry. All projects have achieved their objectives as regards the number of companies and projects recruited. Most of the companies have no or very limited R&D experience or competence. 48 R&D-institutions have been involved.

According to the Research Council BRIDGE seem to be a suitable mechanism for stimulating innovation and R&D co-operation in companies and especially SMEs. The experience from the programme confirms that innovation is an interactive process that requires process-oriented support, time and trust between the participating partners. For SMEs incremental innovation is closely linked to the development of networks. On the other hand, Norwegian policy makers also emphasized the importance of education centers in innovation, thus they concluded that the colleges show great potential as partners in regional innovation, but that there is a need for a change in attitudes and practice.

It is important to connect BRIDGE to other public measures geared towards innovation. For a more efficient and effective working Bridge has been divided into several sub-programs or projects: The TEFT program (Technology Transfer from R&D institutions to SMEs - under the Research Council of Norway). SME-Competence (SMB-kompetanse, under the Research Council of Norway) and REGINN (regional innovation) SME-Colleges. Second the FORNY program and FIIN used to be parts of BRIDGE. They are now organized as separate programs. Thus the criteria to be eligible and the mode of financing depend on the programs.

FORNY Program

The FORNY Programme aims the commercialization of R&D business concepts under the Research Council of Norway, it is administered by the Research Council of Norway and SND. It supports the process for wealth creation by improving the ability to commercialize research-based business concepts or ideas conceived at universities, colleges and research institutes. Its goal is to increase the number of, and quality of concepts in existing companies and/or the process of setting up new innovative companies. Second, to turn the commercialization of research-based business concepts into a strategic area of activity and set up a permanent service of commercialization of research-based business concepts through the establishment of a company that can deal with all aspects of the commercialization process, legal and financial. The main role of government is funding, giving advice to the participants. Target groups of the program are research institutes, researchers, universities.

FORNY is organized as four regional programs. The program is decentralized. The research institutions may apply for funding for projects that will stimulate the generation of new ideas. They co-operate with so-called commercialization units (kommersialsieringsenheter- KE) that are to help them commercialize business ideas. This unit may for instance be a science park. The commercialization unit gets the funding and uses this money with a minimum of bureaucratic restraints. The commercialization unit shall give advice on where to get information and contacts and on intellectual property rights.

The creator of this new idea/product/process must be a student or an employee of a university, college or research institution. The business idea must show unique technological and commercial content or potential. The idea should lead to products/processes that can be exported or that will curtail import. The projects will be given priority on the basis for innovation and usefulness. The funding shall be used on the commercialization, not on the development of the product. However, FORNY may help the creator in getting additional funding from other parts of the public sector or from industry.

The main implications of FORNY are "the number of new ideas and commercialization brought forth within the framework of the program is more or less in accordance with the objectives" (ECTI, 2001). However, they emphasized that the quality and the potential of the new ideas vary a lot, and one should have been more selective when choosing projects. The evaluators suggested that the so-called "hard part" of the commercialization process should be organized in separate limited companies, and that support to the development of innovation infrastructure should be organized regionally and be directed towards the university system. FORNY seems to have led to an increased focus on the commercialization of R&D in universities and colleges. Moreover, The establishment of local "FORNY teams", made up by university/college employees and advisers, considered as success factors. By and large the amount of income from stocks, licenses and royalties would in no way make the regional units profitable in 1998. The evaluators underlined, however, that this was in line with the experience from other countries, where it can take up till 10 years before organizations become profitable. Thus in order to assess the benefits of innovation networking, longer-term results must be counted on. Indeed The evaluators recommended a continuation of the program.

b) TEFT is a national sub-program within BRIDGE financed by the Ministry for Local Government and Regional Affairs and The Ministry of Trade and Industry. It is organised by the Research Council of Norway, who is co-operating with a consortium consisting of the research institutes: SINTEF, Christian Michelsen Research AS (CMR), Rogalandsforskning AS (RF), The NORUT Group and Matforsk. The secretariat is located at SINTEF. Government predominant role is funding the innovation partnership program among its target groups SMEs/Industrial SMEs Research Institutes.

TEFT employs ten full-time technology attaches to work with SMEs. The attaches are the companies' gateway to the technical research institutes. They have linking liaison roles. They often come from the institutes and possess broad-based technological expertise. They determine which companies are the likely candidates for TEFT. They then help the companies to design technology projects, and facilitate contact with relevant researchers. The attaches co-operate closely with regional players in the public sector and with technical research institutes all over Norway.

TEFT shall contribute to enhancing the capability of SMEs both in central and peripheral areas to initiate and carry out R&D projects. They shall thereby contribute to their own and the nation's wealth creation. TEFT shall help the R&D institutions to reorient themselves increasingly towards activities relevant for SMEs, in such a way that co-operation with smaller firms increases and that the knowledge base in these institutions becomes easier accessible for all SMEs. The program shall contribute to a reduction of the barriers that hinders communication and co-operation between R&D institutions and smaller firms. Data suggest that TEFT works well measured against its own goals. Although the results and impacts are not satisfactory in all respects, key impacts have been achieved, like recurring procurement.

Norwegian innovation system focuses on the networking of the all actors from the national educational, industrial and economic system. It started with a general program; recently it has been divided into sub-programs still within the framework of the main program.

B.6.Sweden

Swedish national innovation system has been changed from multiparty agencies to a central coordination mechanism. Vinnova NUTEK ITPS and Swedish Research Council are the main bodies in establishing links between Government, Higher education, Business sector and industrial research centers (Tekes, 2001). Historically a great amount of public R&D resources have been directed to the universities. Recently several measures have been introduced in order to capture the third task benefits of universities as economic and industrial growth. Active Industrial Collaboration and the NUTEK competence center are important new measures in terms of achieving successful university-industry-government relations. Sweden is now ranked to be 6^{th} and 7^{th} in company-university and company-company cooperation respectively.

Active Industrial Collaboration, AIS

The vision for Vinnova is to contribute to R&D-related networking, between small and big companies, universities, research institutes, that can be a basis for long-term relationships, built on confidence that can be utilized by all parties for strengthening and maintaining industrial competitiveness.

The role of government is provider of funding, administrator, catalyser, facilitator, networker. The target groups of the measure are the SMEs/ Industrial SMEs, Research Institutes and Universities.

Vinnova invites groups of companies - directly or via R&D-organizations - to present draft proposals for projects on three occasions during the year 2000. Usually an R&D-organization takes the role of project initiator, building the team of participants and carrying the project leadership. A formal AIS agreement between participating parties, regulating inter alia IPR, is an integrated part of the project.

1. The project must be carried out in active co-operation between at least one Swedish university or University College, at least one Swedish research institute and at least six companies of which at least one has to be small. When these criteria are met, foreign participants are welcome as well.

2. Projects must be defined based on the needs of the companies with a clearly industrial aim and must generate industrial effects that are possible to assess.

3. The goals and expectations of the individual participants as for the long-term effects have to be clearly communicated to all participants.

4. The project must be financed up to a level of 50% by the participating companies in the form of in costs for invested man hours.

5. The companies must participate actively in the planning and the control of the project, in the research and development activities as well as in the dissemination of results to third parties.

6. The funding from VINNOVA is controlled by one participant, usually a research institute, who will also ensure the management of the project website.

7. The project leader has to be a person from a research institute or from a company.

8. The project must contain activities for dissemination of results to third parties.

9. The project must be of use to small companies.

10. The project must be compatible with sustainable development

Vinnova invites groups of companies - directly or via R&D-organizations - to present draft proposals for projects on three occasions during the year 2000. At each one of the three calls for proposals, 10 projects are retained for further development. After this, a big meeting i held by the initiator of the proposal for each project involving all potential industrial participants. When a majority of the companies agree to develop the project further, a project leader is appointed responsible for the process of specifying the content of the project. Additional 2 to 4 meetings are generally held in order to arrive at a final version of the project proposal. The final project proposal is submitted to Vinnova for funding decision.

Financing:

10 million Euro for about 30 projects is allocated. The participation of universities and research institutes is financed by Vinnova to the amount of 320 000 Euro per project. The industry participation is to be equivalent to this amount in costs for man hours. The program runs for a period of three years, the annual expenditure is about 100 000 Euro from Vinnova and 100 000 Euro from industry per project Some projects can receive additional financing from EU.

The impacts of the program is measured by the perceived effect on competitiveness of the project The number of durable new network relationships established for each of the partners involved The project would not have taken place otherwise. The fact that SMEs are actively involved in the project during a period of totally up to four years is a significant indicator of their appreciation and commitment to the projects.

B.7.Canada

Canadian government and policy makers thought Canada had both strategic research gap and innovation gap. It had strategic gap as result of lack of private sector investment in medium to long-term strategic R&D in major industrial laboratories. And it had innovation gap due to the failure of transfer of technology and commercialization of the results from the government and university research establishments. To remedy these shortages and to be leader in the development of an innovative, knowledge-based economy through science and technology Canadian government initiated more than 1600 research collaborations with industry in a wide variety of interactions; like collaborative research projects and centers, facilities-based partnership, incubators, consortia and special interest groups. These programs render Canada to have a strong science-technology & innovation base Canada is ranked 8^{th} both in the university-company and company-company cooperation (WCH, 1999 in Dodgson).

Networks of Centers of Excellence Program is the main program of the Canadian science & technology system in terms of innovation networking. This program is designed to link researchers across the country to foster the development new research and technology and precipitate the obtainment of this knowledge and technology by those who can apply it as improving the well being of Canadians.

It is the permanent program of the government to foster synergetic relations with the producers and users of technology from both public and private sectors. It focuses on critically important areas for Canadians, and to achieve this it encourages multidisciplinary researches and multisectoral programs in national scope. Additionally it is supporting international cooperation between universities, hospitals, and government agencies from UK, Sweden, Germany, the US, France and Australia.

NCE program is designed on institutional linkages at the regional level, and subsequently achieving nation wide development. All over Canada 22 active NCE program are functioning, with more than 5000 employees with a distribution of 1200 professors from universities, more than 350 industrial researchers and participants more than 3600 research associates and students. The institutional participation is more than 900 Canadian organization, which is composed of 90 university & hospitals, 130 governmental agencies, and more than 70 industrial companies (NCR, Report, 2001). They undertake projects mainly under 4 critical science areas and their sub-programs. Health, human development & biotechnology, ICT, natural resources and environment, and engineering & manufacturing areas and related.

NCE management is designed to carry out the research and business functions of a complex multidisciplinary, multi-institutional organization in compatibility and in integrity. They need to have an effective board and committee to ensure the appropriate policy and financial decisions as well as effective research planning, budgeting mechanisms and efficient internal-external communication strategies (NCR, Letters of Intent, 2000). A typical NCE has board of directors and is composed of 15 to 25 projects, focussing on 4 to 6 themes. It has 50-60 professors from 12-20 universities, 100-150 associate researchers, and 20-50 companies. It has a budget of $CDN 3-6 million per year. The additional financing can be supplied from partners cash and in-kind and secondly from individual research grants.

Even though participants from private sector and government are encouraged to play active role, they are not eligible to receive NCE funds. Universities, hospitals, post-secondary institutions with a research mandate can receive research funds. Industry consortiums can receive funds to administer a network. The criteria for the selection of the proposed network are based on first how much it integrates the relevant stakeholders from industry, university with government priorities. Second is the approximate budget and the advantages (impacts) to Canadian socio-economic context; an assessment of pros and cons and the level of the synergy of proposed network in comparison to other efforts, consortia or initiatives. Third main point is related with the network's strategy to train highly qualified personnel and to increase the marketability of trainees according to the needs of industry. Next is the knowledge exchange, technology exploitation, potential for new products, enhancement of Canadian industrial base, and productivity. Last but not least is the strong management structure, with clearly defined responsibilities for shaping the strategic plan and direction of the network.

The impacts of NCE beside expedition of the commercialization of technology, NCE are accomplished the establishment of 78 spin-off firms in the last decade, which made the 10% of total university spin-off (35 spin-off till 1997 and 14 spin-off in 1999\2000). NCE achieved the 66 patents acceptance, 31 awards, 73 licenses (43 in negotiation process, 2000). These lead to the creation of new jobs and employment of more than 143 employees (1997). And it accomplished the training of more than 1500 students as highly qualified personnel in the strategic areas for research and innovation. The detailed success stories of each consortium are available in the web page of NCE, 2000).

Utterly the Evolution Report of ARA Group on the NCE (1997) confirmed the success of NCE in these objectives. "The support of excellent research, train and re-train HQP, management of multidisciplinary, multisectoral projects, accelerate the knowledge exchange and technology transfer". 1999 Conference Board of Canada stated the rise in the innovation, introduction of new process and products from 10% to 20% under NCE program and the collaboration helps the filling of innovation and strategic gaps. They concluded the program as a net positive economic and social contributor to the country.

B.8.France

In the World Competitive Handbook (1999 in Dodgson), France has been ranked 27^{th} and 22^{nd} in terms of university-company and company-company respectively. However, according to Country Report of France, the networking between universities and research centers is one of the target areas. Additionally, there is a number of on going programs that work complementary to each other. Such as National Centers for Technological Research and Innovation Networks, Project of Technological Platforms, Seed-capital Fund, Incubator structures, in this study, the program for the "Projects on Key Technologies" is presented.

This program is a government initiation and functioning under the umbrella of ANVAR, National Agency for Research Development. It is an updated program of a previous measure. Its aim is strategic research and development on several priority areas that has strategic importance for France within a time horizon of 5 to 10 years. Such as the following, health and technologies of life sciences, environment, information and communication technologies, materials, organizational technologies, production sensing and measurements (ECTI, 2000, France Country Report). For this end the program targeted at the cooperation and interaction among universities, SMEs, Large Companies, and research centers. The government plays the role of a facilitator and investor. The partnership of domestic these actors as well as European partners are welcomed. The projects need to yield results, products within 5 years.

The projects are financed on this basis bidding company receives a subsidy or a reimbursable advance payment amounting to 50 per cent of the cost for a feasibility studies. The maximum amount allowed is, EURO 76,000. For the project development phase, the company will receive a reimbursable advance payment amounting to 30-40 per cent of the costs incurred. In this model the bidding company needs to pay the money back.

Similar to the other project measurement, the success of the program is assessed with regards to the increase in the numbers of companies that participate, and well-balanced sectoral distribution of the funds. However the participation of medium size companies is not at a desired level. Overall the program is rated to be successful and contributing to the total innovation score of France.

B.9.Germany

The German innovation system is one of the most complex models because of its size federal structure, and its economic development process. Compared to the international level, technology oriented networks between firms and public research institutions in Germany are rich and complex. According to the WCH statistics, Germany is ranked 4^{th} in company to company technical cooperation, however it is 13^{th} in university industry cooperation (Dodgson, 1998). Thus the encouragement of technology transfer and the utilization of the potential of the academia is of paramount importance in the policy of reseach and education (Shefer, et al. 2000). For this objective new measures in the fields of intellectual property rights, technology transfer institutions and use of internet as a tool for technology transfer between science and industry were announced (ECTI, Country Report of Germany).

The new measures in Germany include: Bio-profile, Learning Regions, ZUTECH. The ongoing programs are InnoNet, Competence Networks in Medicine, Exist and Networks of Competence.

Networks of Competence

The main program in reference to university-industry-government relations is the Networks of Competence measure. This initiative by the BMBF seeks to promote networking among science, education and enterprises in order to bundle competence and to present internationally attractive networks to the world. The initiatives support the establishment of such networks and the presentation of the network on the Internet. The initiative aims at promoting co-operation within top-level technology networks. Centers of Competence, which are supported via the thematic programs, are part of the total of 38 networks of competence at the moment.

This initiative was established by the BMBF in order to bring together main actors in the fields of education, science and the enterprise sector within a certain field of technology. Cooperation among actors should increase trust, reduce information asymmetries and strengthen competitiveness within a field of technology, especially in new technologies intensify international cooperation in young fields of technology.

The role of government is as promoter, and funding the source. The target groups of this program are: Large Companies/Large Industrial Companies SMEs/Industrial SMEs Research Institutes Universities Researchers Graduates Public Authorities.

Organization:

The initiative is managed by VDI-Technologiezentrum. It is responsible for setting up and maintaining the homepage and for public relation and marketing activities. Networks are built up on private initiatives. Public support is provided for communication and cooperation within networks. There are, however, no public subsidies delivered to network partners, but support is given via services marketing, consulting, provision of a homepage. Initiatives who want to establish a network of competence have to apply to the management. A jury decides on whether to allow a network to present itself on the platform (EU Trend Chart on Germany , 2000).

Eligibility:

To be accepted as a network of competence, networks must have a thematic and regional focus. It must consist of a larger number of partners who show high performance and interact intensively among each other, moreover it must have an innovation orientation among its members and both a vertical and horizontal network structure. Finally, it must possess the potential to generate world-leading innovations (EU Trend Chart on Germany, 2000).

Financing:

For the management and marketing, approximately 2 million Euro are provided by the BMBF. Networks are financed by own resources or via sponsoring R&D activities within networks are financed by other sources. Moreover each year about 0.5 million Euro is allocated for providing the platform between the participants (EU Trend Chart on Germany, 2000).

Exist: Promotion of University-based Start-ups

A very successful second case is the German Federal Government's EXIST program. In December 1997 it was launched by the Federal Ministry of Education and Research (BMBF) as contest (Koschazky, 2001). It supports the formation of several regional networks of universities, research institutes, venture capitalist, private companies, and consultants; chambers of trade and commerce, science parks and business centers.

For participation at least three different partners from a region need to work together, and one of the actor must be higher-education institute. In 1998, 12 most promising proposal out 109 were pre-selected and then 5 of them were chosen to share 15 million Euro per year. The participants range from 15 to 60 per region (EU Trend chart 2001, Koschazky, 2001).

The Exist program is accompanied by some complementary measures such as:
Virtual Academy for Entrepreneurs,
Pilot structures in the field of intellectual property rights,
A common news letter,
Seed capital fund,
Accompanying action research program run by the Frounhofer ISI Institute,
Exist- High-tech, High technology Entrepreneurship Post-graduate program which aims at the training of young academics, the support of start-up projects and the training of managers in biotechnology, pharmaceutical and information technologies (ECTI, Germany Country Report, 2001).
Additionally, German Innonet program is another measure seeking to accelerate the transfer of R&D into innovative product processes and services by initiating innovative collaborative projects between SMEs and government funded research institutions. The project team is made up at least two research organizations. (they receive the grants) and at least four SMEs. The project can be targeted to any type of sector; there is no limitation however projects with competitors, and maximizing the range of competence available to the project considered being superior over the standard ones (Sweden Wamp Report, 2001). German Innonet program focuses and encourages competitors to work together. Indeed this is the most difficult type of network to achieve but apparently it has the highest social vantages (Sweden Wamp Report, 2001).

In Germany, there is always the feeling that such networking, involving several enterprises may weaken competition, as networks may not be restricted with sole R&D activities (European Commission Report). However the acceptance that most efficient way of transfer of knowledge between public institutions and the private sector is the face-to face transfer of tacit knowledge and the observation of the positive impact of Exist program on German high-tech renders the importance of networking in German context as well. Unquestionably, Germany has a wide range of networking policies targeted on different scientific fields, thus in its entirety the programs are considered to be working efficiently and complementarily.

B.10.Japan

For decades Japan has focused on applied R&D facilities. A higher proportion of Japan's R&D activities are privately supported that in other developed countries (World Bank, 1992). This is also evident in while Japan is ranked 3rd in company-company cooperation, it comes 26th in university-industry cooperation (WCH, 1999 in Dodgson). As the government has realized the importance of basic research or university-industry relationships for its economic welfare, and recognized the importance of "win-win" possibilities of partnerships, programs promoting the university-industry relations are increasing (Hane, in Branscomb et al. 1999, p.23).

Rosenberg (1990), stated the emergence of new initiatives to render incentives for private industry to support greater portion of the country's R&D activities, and promote industry-university collaboration. Japan initiated the "Contract Research Program", which allows universities to employ industrial scientist and engineers on contractual basis to conduct research (World Bank Report, 1992, p.17).

Second, Japanese Ministry of Trade & Industry (MITI) initiated Centers for Cooperative Research between the national universities and private industry.

Within 1 year 8 universities developed such centers (Sigurdson & Annes, 1991 in World Bank Report, 1992). More recently, Japan science & technology agency (STA) initiated Exploratory Research for Advanced Technology program, which aimed to improve the quality of research in the Japanese system by bringing together university professors, industry researchers, and scientist from national laboratories. Under this scheme researchers undertake a project of 5-year duration. Koizumi, (1993) and EROTO Evaluation showed the slow change in the Japanese science culture to advance into joint projects between industries and universities. Even if it is hard to measure the place of university in the Japanese innovation progress, the increase of $100 million in the funding of Japanese government for such programs as well as extension of such programs support the idea of the importance of basic science for further innovation and progress. (NSF, Japan-US comparative Study)

B.11.The United Kingdom

UK is ranked 20th and 26th in the cooperation between the university-company and company-company cooperation. The LINK scheme is one of the main mechanisms for promoting partnership in pre-competitive research between industry and research base. The scheme provides the industry with the access to academic knowledge to tackle new scientific and technological challenges, as well as it offers opportunities for researchers from industry and academia to acquire new knowledge and skills to develop new technologies (Sweden Country Report).

Government is funding the program at a share 50% per joint university industry projects according to the target areas of UK Foresight Study. The target groups of the measure are the companies and research organizations throughout the UK. The LINK is organized into a number of targeted programs, which are coordinated by a program coordinator and which have a number of sub-programs.

Any university department or R&D department of any the firm can contact the LINK coordinator for the program who is responsible for program administration. Generally university departments take a leading role in identifying the partners. The main motivation is to tap the universities into the industrial networks. In most of cases the applicants have a good knowledge of the collaborators and apply directly or rarely the program coordinator can act as a "marriage broker" and suggest potential partners. Additionally, they assist applicants with administrative requirements (Sweden Wamp Report, 2001, p.4). Subsequently a group of 2-6 industrial partner, with a supply chain arrangements and complementary resources and plus university department(s). The organization of meetings and workshops depends on the will of program managers, though the program manager can make discussion forum.

The initial project proposal must demonstrate the existence of market potential and must involve innovative pre-competitive research between industry and academia. After having reviewed and evaluated on these criteria by the program management committee, the group is left alone to develop a full proposal of a business plan. Projects are peer reviewed and assessed by program management committee that is made up of industry, government departments and research councils. While the Research councils assess the support to universities; government departments are responsible for support to industry. 33% of project proposals have been selected as successful. The projects led by industry are found to have a better uptake, as reflecting more market needs.

It needs to show where the project will be exploited and a collaboration agreement, which covers the sharing of the intellectual property rights resulting from the project. However, arrangement of intellectual property rights varies from project to project as long as the participants agree. Thus, the technology transfer depends on the IPR arrangements; however, it is requirement of the scheme that exploitation should be taken place in the UK. Technology transfer occurs within and across projects, the program managers are responsible for encouraging cross project dissemination and events.

Within LINK the aim is to "support transfer of knowledge from academia to industry not to support research in alternative research organizations" (Sweden, country report). Overall, the Swedish reporters concluded LINK is as an effective, well-established program achieving the importance of critical mass for the UK national innovation system.

B.12.The United States of America

The US is ranked 7th and 13th in university-company and company-company cooperation respectively (WCH, 1999 in Dodgson). This rating is based on the US general perception on the importance of science & technology on the US well being. During 1980s the US National Science Foundation (NSF) established several programs, such as the "Engineering Research Centers" program that supports interdisciplinary research that is performed collaboratively by universities and industry. The aim of this program is to link the scientific and engineering capabilities of the nation to achieve "next generation technological advances". ERCs are aiming to develop a new type of engineer who has an integrated cross-disciplinary technology view from research to production (NSF, 1988; World Bank, 1992). Second outstanding program in the US is the "Industry/University Cooperative Research Centers" program. The goals of this program are first to develop industry, state and other support for industry-university interaction on 'industrially relevant' fundamental research topics, second to promote university research to provide a knowledge base for industrial and technological advancement as well as training students, third to promote research centers that become 'self-sustaining with industry', state and other funding within a five-year period (NSF, 1988; NSF1989). The importance of industrially relevant projects and being self-sustaining are important characteristics of the I/UCRCs program. While the first program (ERCs) receive on average US$ 2 million per year from NSF and additional funds from industry, I/UCRCs receive between US$ 50,000 to $100,000 from NSF and require a total of US$ 300,000 from at least six firms in order to have a sufficient research base.

APPENDIX C

C. Figures on the facts of R&D inputs of Countries

Figure.C.1 Total Researchers-Population in Israel & Reference Group

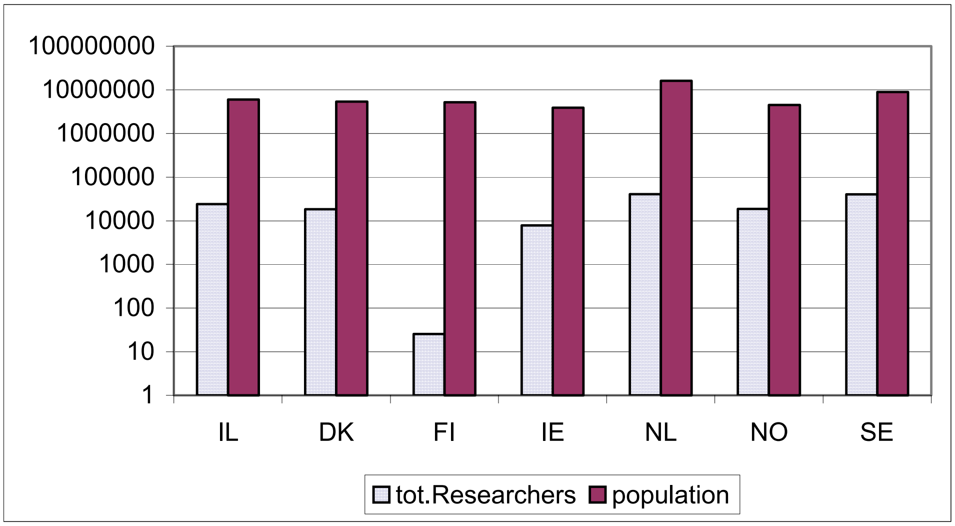


Figure.C.2. GERD as % of GDP & % of financing sectors of GERD in Israel & Reference Group

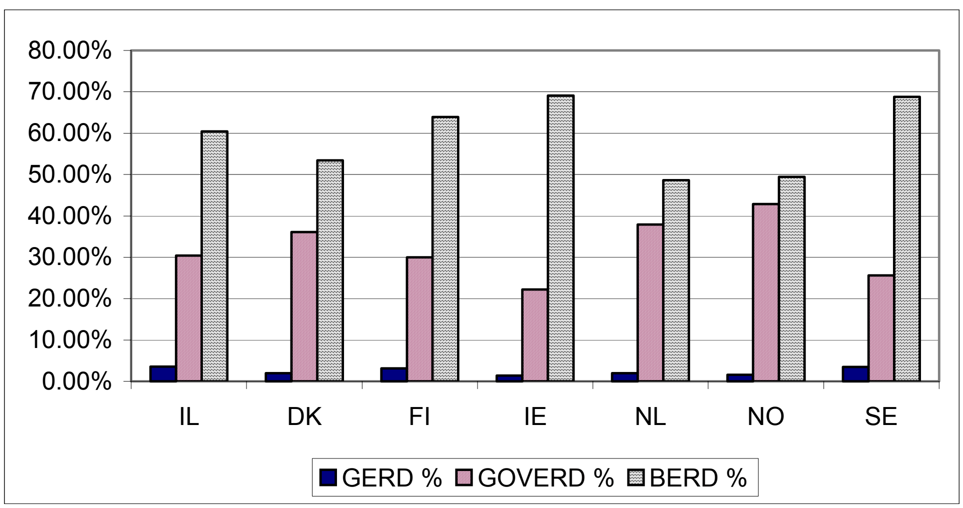


Figure.C.3. GDP per capita & GERD per capita in Israel & Reference Group

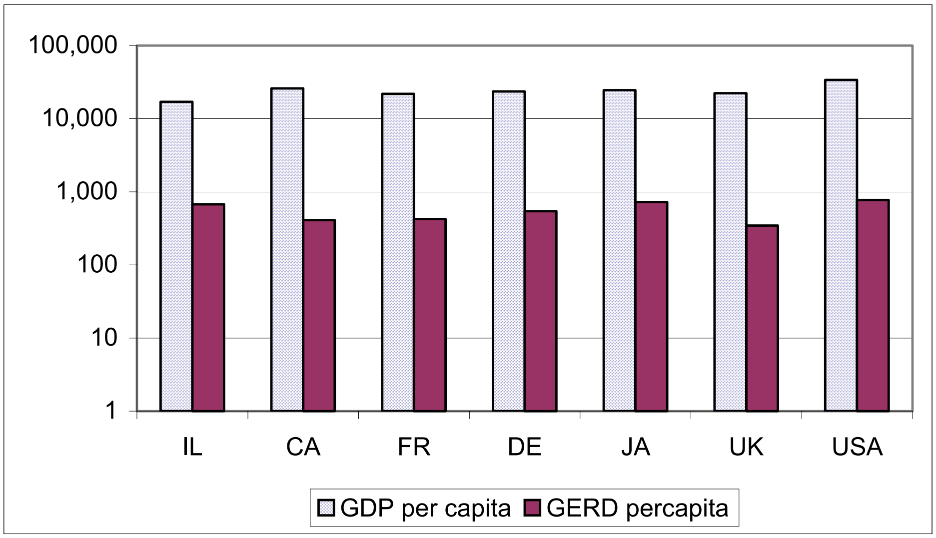


Figure.C.4. Total Researchers-Population in Israel & 2nd Group

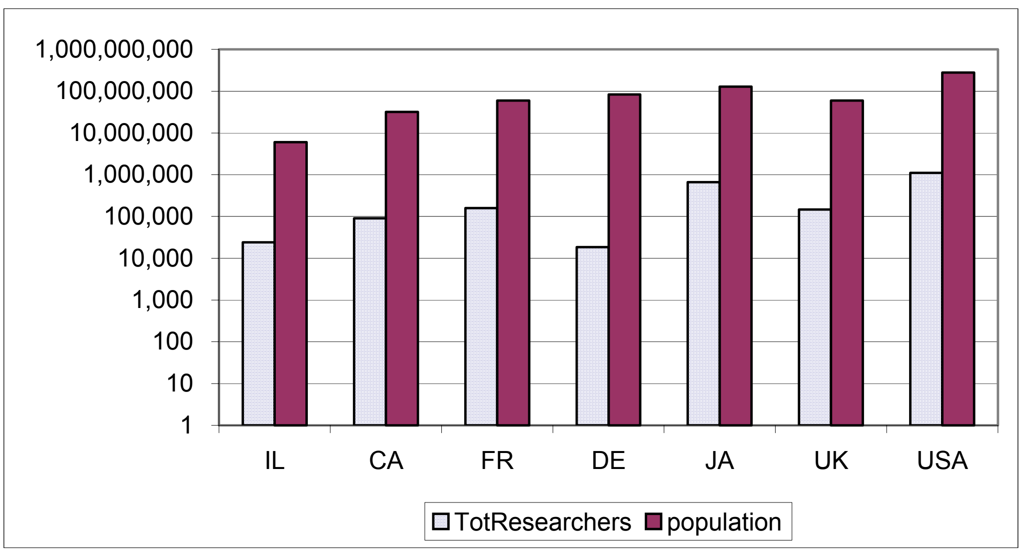


Figure.C.5. GERD as % of GDP & % of financing sectors of GERD in Israel & 2nd Group

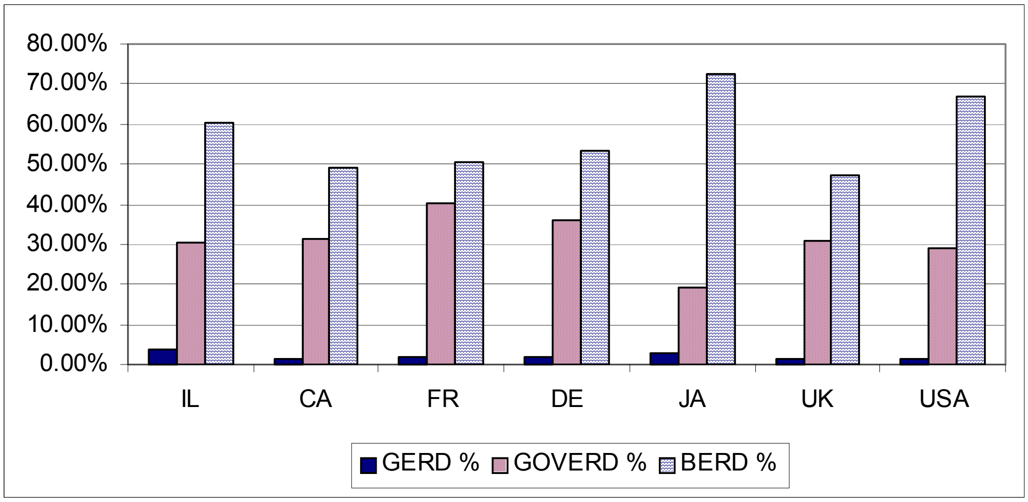
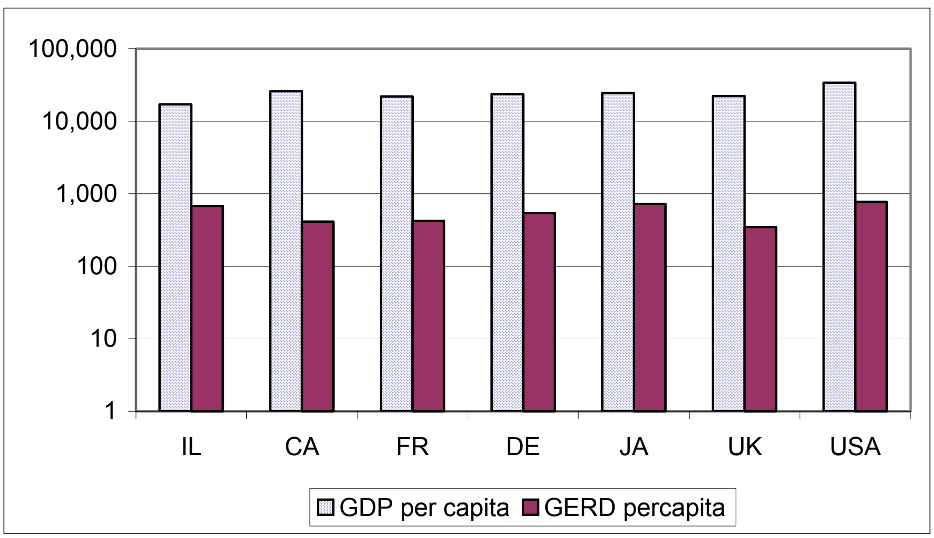


Figure.C.6. GDP &GERD per capita



APPENDIX D

D. University Government Industry (UGI) Configurations

Figure.D.1. Socialist \Estatist Mode of UGI Relations

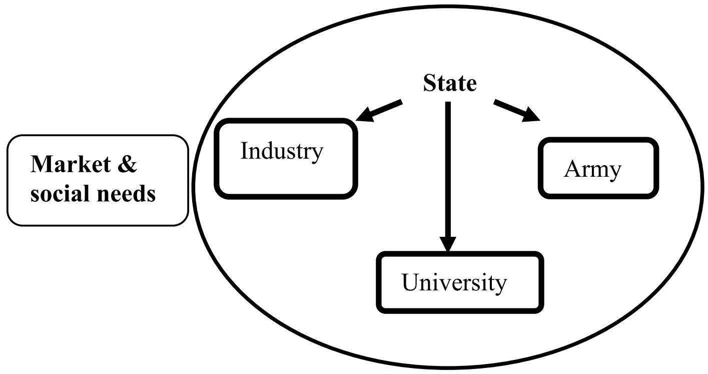


Figure.D.2. Laisess Faire Mode of UGI Relations

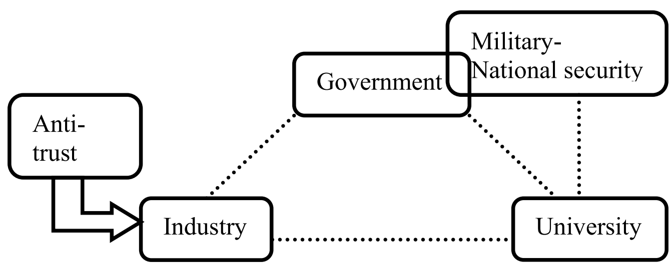
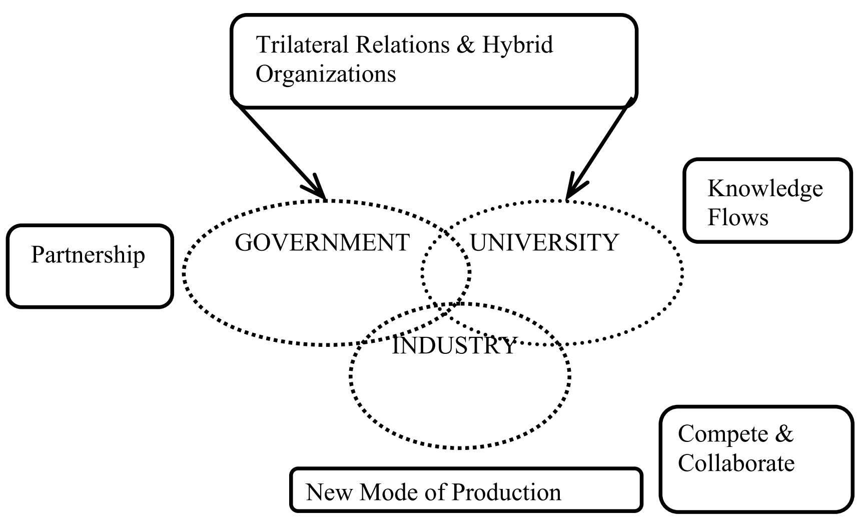


Figure.D.3. Triple Helix of UGI relations



APPENDIX E

E. The Questionnaire for the Magnet Consortia Participants

Samuel Neaman Institute for Advanced Studies in Science and Technology
Technion City Haifa Israel

7/17/2002

To: Industrial Academic Participants of Magnet

Dear Coordinator

Devrim Goktepe is a graduate student at the Department of Science & Technology Policy Studies, in the Middle East Technical University, Ankara\Turkey. She has received grant research scholarship from the Ministry of Foreign Affairs of Israel and she is doing her research study at the Neaman Institute.

Her research thesis deals with national innovation networking programs and focuses on models that describe cooperation between university, industry and government (UGI). The Magnet program is a good example to such model and therefore was selected as a case study in this research. For that purpose a questionnaire was built. The questionnaire is designated to members of Administrative Boards of Consortium, industrial participants and academic & \or industrial coordinators on the functioning and impacts of consortia.

The included questions deal with general perception, functioning, satisfaction and impact of Magnet Program on Israel economy, as well as on the participants. Additionally, we request some further suggestions for the improvement of the program.
I would appreciate your support in fulfill the attached questionnaire. Your assistance will help to complete the research study. I assure you that the data will be kept confidentially and will use only for statistical analysis.
Yours Sincerely
Prof. Arnon Bentur
Director

Name:	
Name of the Consortium:	
Name of the institution\or company:	Telephone:
Please identify your role(s) in the Magnet Consortium, please check all that apply with "X"	
Industrial Participant:	
Academic Participant:	
(Academic) Member of the Board of Consortium:	
(Industrial) Member of Board of Consortium:	
Academic Coordinator:	
Industrial Coordinator:	
Magnet or \ Chief Scientist Representative:	

1. Rationale of Magnet Program

In order to answer questions please put an "X" under the relevant number for that factor.

On a scale from 1=less important to 5=very important, please rate the importance of the factors behind the initiation of Magnet program by the Israeli State in 1992.

Government's Reasons for Magnet	1	2	3	4	5
Better interaction between Science & Industry					
Better utilization of science (Academy) Potential					
Demands of Industry					
Increasing high-tech export capability					
Pooling of national resources					
Reduction of relying on foreign technology					

2. On a scale from 1=less important to 5=very important, please rate the importance of the factors behind the participation of industry in Magnet consortia.

Industry's Reasons	1	2	3	4	5
Access to knowledge pools					
Competence Gap					
Control Gap					
Cost Reduction					
Information Gap					
Profit Maximization					
Risk Reduction					

3. On a scale from 1=less important to 5=very important, please rate the importance of the factors behind the participation of academy in Magnet consortia.

Factors	1	2	3	4	5
Financial constraints in academy					
Industry committed research					
Employment options for graduates					

B) Structure of Magnet Consortium

4. Networks require close interactions. On a scale from 1=less successful to 5=very successful, please rate the success level of interactions between these actors in your consortium.
5.

Factors	1	2	3	4	5
Interactions between government &					

industrialists					
Interactions between government & academicians					
Interactions between industrialists & academicians					
Triple interaction between these three groups mentioned above					
Interaction between consortium & customers					

6. Networks have several qualifying factors for the creation of synergy among the participants. On a scale from 1=less successful to 5=very successful, please rate success of your consortium in achieving these following items for a successful cooperation.

Factors of Synergy	1	2	3	4	5
Application & use of Information Communication Technologies[17]					
Bridging different groups' interests					
Commitment\ devotion of all partners					
Confidence Security & Trust					
Consensus over intellectual property rights					
Convergence for longer-term cooperation					
Efficient role of Board of the consortium					
Equity\balance between the partners					
Funding and research stability					
Similar objectives of all partners \harmony\collective belief common culture					

7. On scale from 1=not at all important, 5=very important, please rate the importance of the cooperation and synergy between the participants for the success of the consortium.

1	2	3	4	5

8. On a scale from 1=not at all changes to 5=essential changes, please rate the changes that your company experienced since participating in MAGNET program. (Or if you are not a industrial partner please rate your observations in the companies)

Characteristic of changes	1	2	3	4	5
Consent for longer-term results					
More co-operative					
More export-oriented					
More science-oriented					

C) Impacts of Magnet Network

9. On a scale from 1=less important to 5=very important, please rate the success of your consortiums in the accomplishment of the targets of a successful \ effective innovation network.

Better optimization of R&D inputs

Factors	1	2	3	4	5
Eliminating Duplication of R&D inputs					

[17] ICTs:information communication technologies: Internet, multimedia, web based knowledge sharing, computerized databanks.

Decrease in R&D equipment costs					
Decrease in R&D personnel costs					
Decrease in the time-span for R&D\or product introduction					

R&D Innovation Outputs\ Outcomes

Factors	1	2	3	4	5
Access to knowledge, education & research pools					
Access to state funds					
Allocation of resources other than R&D					
Assisting knowledge sharing interactive learning					
Contribution to higher-education					
High-potential for firm creation					
Improvements in human capital					
Increase in R&D innovation capability & capacity					
Increase in the # of patents application\scientific papers					
Increase in the product quality					
Increase in the product variety					
Better R&D results					
Reduction of costs & risks					
Speed-up commercialization of Knowledge \technology transfer					

10. On a scale from 1=possibility to 5=high impossibility please rate the possibility that these outcomes could be achieved without participating in MAGNET program.

1	2	3	4	5

11. On a scale from 1= not interested to 5=high motivation, please rate your company's motivation for re-participation in Magnet programs after the completion of the current project. If you are not an industrial participant please rate your own desire \ motivation for re-participation in Magnet.

Motivation	1	2	3	4	5
Company					
Academic staff					
Coordinator\ Representatives					

12. On a scale 1=not at all to 5=full satisfaction please rate the overall success of Magnet program in meeting your reasons to participate.

1	2	3	4	5

13. Or on a scale 1=not at all to 5=full satisfaction please rate the overall satisfaction that you (as an academic \industrial participant) have gained from Magnet program. If you are a coordinator \or Office of Chief Scientist representative please rate your observation for academy and industry.

Satisfaction	1	2	3	4	5
Industry					

Academic staff					

14. If you are an industrial participant on scale from 1= not at all difference, to 5=big amount of contribution, please rate the importance of your company's outputs or \expected outcomes into the national innovation system in comparison with pre-magnet figures.

1	2	3	4	5

15. On a scale from 1=less important to 5=very important, please rate the importance of MAGNET in strengthening research conditions in company.

1	2	3	4	5

16. On scale from 1=less important to 5=very important, please rate the importance of MAGNET in accumulating assets for academia.

1	2	3	4	5

17. On a scale from 1=less important to 5=very important, please rate the importance of MAGNET in stimulating research conditions in academia.

1	2	3	4	5

18. On a scale from 1=unsuccessful to 5=very successful, please rate the success level of dissemination of knowledge outside the consortium members.

1	2	3	4	5

Optional:

19. If you have further suggestions to be adapted for the betterment of Magnet program, please state your views?

Thank you very much for your kind participation to refine my master thesis.

You are kindly asked to send the filled questionnaire by the envelopes addressed to Samuel Neaman Institute.

If you have any questions please contact me at devrim@tx.technion.ac.il or (04) 829 55 79

Devrim Goktepe