DOES PARTICIPATION IN INTERNATIONAL R&D NETWORKS ENHANCE LOCAL DYNAMISM? RESEARCHER LEVEL ASPECTS FROM TURKEY

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF SOCIAL SCIENCES OF
MIDDLE EAST TECHNICAL UNIVERSITY

BY

HÜSEYİN GÜLER

IN PARTIAL FULFILMENT OF THE REQUIREMENTS
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN
THE PROGRAM OF SCIENCE AND TECHNOLOGY POLICY STUDIES

SEPTEMBER 2013

Approval of the Graduate School of Social Sciences

_____

Prof. Dr. Meliha Altunışık

Director

I certify that this thesis satisfies all the requirements as a thesis for the degree of Doctor of Philosophy.

_____

Prof. Dr. Erkan Erdil

Head of Department

This is to certify that we have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Doctor of Philosophy.

_____

Prof. Dr. Erkan Erdil

Supervisor

Examining Committee Members

Prof. Dr. Ahmet Ademoğlu	(ŞEHİR, ENG)	_____
Prof. Dr. Erkan Erdil	(METU, ECON)	_____
Prof. Dr. A. Rıza Özdemir	(TÜBİTAK, INCO)	_____
Assoc. Prof. Dr. M.Teoman Pamukçu	(METU, STPS)	_____
Assist. Prof. Dr. İ. Semih Akçomak	(METU, STPS)	_____

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Name, Last name: Hüseyin Güler
Signature:

ABSTRACT

DOES PARTICIPATION IN INTERNATIONAL R&D NETWORKS ENHANCE LOCAL DYNAMISM? RESEARCHER LEVEL ASPECTS FROM TURKEY

Güler, Hüseyin
Ph.D. in Science and Technology Policy Studies
Supervisor: Prof. Dr. Erkan Erdil
September 2013, 206 pages

This study elaborates on the involvement of Turkish ICT researchers in Framework Programme 6 (FP6) networks and in other TÜBİTAK funded international collaboration projects with regard to the question of whether global pipelines enhance the local buzz.

It provides a novel taxonomy to identify the degree of globalisation versus localisation of ICT scientists in Turkey. Based on international and national project portfolios of Turkish ICT researchers who participated in FP6 and other international projects between 2003 and 2006, four groups were formed in terms of their degree of local or global foci. For the period of 2007–2013, global and local performance of the same population was traced with respect to its international or national project density, publication output, involvement in decision making processes on academic project funding, and contribution to R&D capacity development in the private sector.

Findings of the quantitative part of the study show that globally and locally integrated researchers seem to be the most productive actors in the Turkish innovation ecosystem. Considered as the best international collaborators from a country at the periphery of EU R&D networks, they are contributing significantly to the local research base.

Policy recommendations at the micro, meso, and macro levels suggest that there is a need for performance tracking of researchers. Based on evidence from such chronological data analysis, new policy tools beyond the one-size-fits-all approaches can be applied, highlighting the issues such as heterogeneity, career levels, national priorities and capacity requirements of the research ecosystem.

Keywords: EU Framework Programmes, international R&D networks, local buzz–global pipelines, knowledge flows, information and communication technologies.

ÖZ

ULUSLARARASI AR-GE ŞEBEKELERİNE KATILIM YEREL DİNAMİZMİ ARTIRIR MI? TÜRKİYE'DEN ARAŞTIRMACI DÜZEYİNDE ÇIKARIMLAR

Güler, Hüseyin
Doktora, Bilim ve Teknoloji Politikası Çalışmaları
Tez Yöneticisi:Prof.Dr.Erkan Erdil
Eylül, 2013, 206 sayfa

Bu çalışma küresel işbirlikleri yerel yerel hareketlilik doğurur mu sorusuna 6.Çerçeve Programı (6.ÇP) ağları ve TÜBİTAK tarafından finance edilen BİT araştırmacılarının projelerini inceleyerek yanıt oluşturmaktadır.

Çalışma ayrıca Türkiye'de bilgi ve iletişim teknolojileri alanındaki bilim adamlarının küreselleşme-yerelleşme derecesini belirlemek için yeni bir sınıflandırma sağlamaktadır.

Hem yerel hem de uluslararası Ar-Ge fonlarının mevcut olduğu bir ortamda araştırmacılar ulusal bazda ya da kürsel ölçekte çalışmayı tercih edebilirler veya ikisi arasında dengeleri bir duruş da sergileyebilirler. Araştırmacıları hangi ölçeğe daha çok ilgi duyduklarını görmek için birbirini takip eden iki farklı zaman diliminde ulusal ve uluslararası proje bazlı birikimlerini 2003-2006 verileri çerçevesinde haritalandırdık. Farklı katılım düzeylerine göre de dört grup oluşturduk. Oluşturulan bu grupların 2007-2013 yılları için ulusal ve uluslararası projeler, yayın çıktıları, ulusal seviyedeki Ar-Ge yönetişimi

çalışmalara katkı, özel sektör Ar-Ge kapasitesinin gelişimi için ortaya konan çalışmalar gibi beş boyutta performansları ölçüldü.

Sayısal çalışmanın bulguları her iki yönde de etkin olan araştırmacıların populasyonun en başarılı bilim insanları olduklarını ortaya koyuyuor. Bulgular ayrıca. AB Ar-Ge ağlarının çevresinde olan bir ülkenin uluslararası ortakları güçlü olan araştırmacıların yerel araştırma tabanına önemli ölçüde katkıda bulunduklarını ortaya koymaktadır.

Mikro, mezo ve makro düzeyde sunulan politika önerileri araştırmacıların performans takibinin yapılmasına ihtiyaç olduğunu ifade etmektedir. Kronolojik veri analizi ile gelen delilller tek bedene uyan uyan yaklaşımlar yerine farklı aktörler arasında heterojenliği, farklı kariyer seviyelerni, ulusal öncelikleri, araştırma ekosistemin kapasite ihtiyaçlarını dikkate alan ve farklı aktörler arası sinerji oluşturmaya politikalara olan ihtiyacı ortaya koymaktadır.

Anahtar kelimeler: AB Çerçeve Programları, uluslararası Ar-Ge işbirliği, yerel hareketlilik-küresel hatlar, bilginin yayılımı, bilgi ve iletişim teknolojileri

To my grandfather and grandmother

TABLE OF CONTENTS

LIST OF TABLES

TABLES

LIST OF FIGURES

FIGURES

CHAPTER I

INTRODUCTION

1.1. Context and Aim of the Thesis

The primary aim of this study is to highlight the significance of local buzz created by Turkish researchers belonging to EU-funded information and communication technology (ICT) R&D and other TÜBİTAK-funded international collaboration projects. In other words, this thesis is about global pipelines' effects on local buzz. The thesis documents the role of globally and locally engaged researchers in the innovation system of an emerging economy.

It is supposed that, the particular combination of local buzz and global pipelines enhances knowledge creation within a research ecosystem (Bathelt, 2007). In line with the global pipelines–local buzz framework, this study looks from the perspective of universities at emerging economies which are participating in international R&D networks formed to conduct frontier research in advanced technology fields. It gives clues about research dynamics of emerging economy universities that are mostly benefiting from national funds and do not have dominating or core roles in international R&D networks. Barnard et al. (2012) analyse global pipelines–local buzz at the researcher level in scientific publications, while this thesis further adds project-based analysis to the literature while also taking other types of contributions to the local system into account. This type of analysis can be considered as a unique approach, because in fields like biotechnology, pharmaceuticals, and ICT, collaboration networks are at the core of new knowledge generation and are dominated mostly by the organisations of advanced countries. This is why most studies are about the dynamics of

developed countries. Considering the lack of studies about research dynamics of emerging economy universities, an additional aim is to contribute to the debate about the internationalisation of R&D by putting emphasis on the local impact of international collaboration and to derive practical policy recommendations at micro, meso, and macro levels.

From the evolutionary perspective of innovation, research collaboration and external knowledge flows are seen as important catalysers for acquiring new capabilities for innovative organisations which cannot rely only on an internal knowledge base (Castellani et al., 2006). The theoretical framework followed in this thesis is based on contemporary studies of innovation from the perspective of evolutionary economics, the core–periphery model of economic development, and recent literature on research networks and sociology and organisation of science in emerging economies. Following Krugman's core–periphery model of economic geography, this study is grounded on local deployment of knowledge gathered from international R&D networks and, based on the findings; it provides feasible policy recommendations for the countries at the periphery in order to enhance synergies between local buzz and global pipelines.

In this thesis, both qualitative and quantitative methods are applied within the timeframe of 2003–2012, focusing on global and local buzz generated by Turkish ICT researchers that take part in EU-funded R&D projects and other international projects funded by TÜBİTAK. Different than EU level studies on ICT research such as that by Malerba et al. (2006), this study brings together the national and international portfolios and matches them to set the degrees of localisation versus globalisation at researcher level. Therefore, project portfolios of Turkish ICT researchers are divided and analysed within two time intervals. The first period is between 2003 and 2006, which encompasses the timeframe of FP6. The second period covers the period after finalisation of FP6 until July 2013.

In order to obtain insights regarding the paths followed after participating in international collaboration, descriptive analyses linking different datasets are performed prior to generation of a taxonomy to map the density of global versus local foci of researchers. Similar to Graf (2011), the taxonomy is formed based on four groups while arguing that different groups have different research outputs in a certain period of time. This argument is tested on the basis of key indicators like international or national project density, publication output, involvement in decision making processes on academic project funding, and contribution to R&D capacity development in the private sector for the period of 2007–2013. Using the two-sample t-test, differences or similarities among the groups are analysed.

After justification of the four groups for positioning the globally and locally based project portfolios of researchers, the study focuses on finding statistically significant answers for why such a grouping exists. This part holistically covers the period between 2003 and 2013 without dividing it into two time intervals and traces the backgrounds of researchers while examining the similarities and differences in their PhD educations, publication outputs before 2003, university research ecosystems, and work experiences after PhD fulfilment.

The final parts of the study are constructed with findings of in-depth interviews and focus groups, which assist in setting policy recommendations to exploit the synergy between global pipelines and local buzz for the benefit of a national innovation ecosystem.

1.2. Originality of the Thesis and Research Questions

The originality of the thesis comes from two different strands. First, the thesis adds a provocative approach to the local buzz–global pipelines concept in questioning whether global pipelines enhance the local buzz. Second, this study is the first comprehensive attempt to investigate the involvement of

Turkish organisations in pre-competitive international R&D collaboration networks linking the national research base.

Today, studies on international R&D collaboration are mainly focused on linkages between organisations of developed country themselves and much of the literature on research collaborations is about the networks established among organisations in advanced countries. In other words, they are about the on-going knowledge exchange within the developed world. In such a picturing of networks, the involvement of the emerging economy in pre-competitive international R&D collaboration networks and especially its impact on local knowledge capacity development is an area of knowledge that remains to be unlocked. Moreover, there is no sufficient evidence for positive externalities created by macro-programmes like the EU Framework Programmes for the benefit of laggard member states and other participant countries at the periphery.

A recent study[1] conducted by METU TEKPOL portrayed the positioning of Turkish organisations in EU-funded projects under the FP6 IST theme (Erdil et al., 2011). It also mapped the Turkish potential in ICT fields while highlighting the main barriers and challenges of Turkish organisations for more participation in Framework programmes. The study also covers legal and policy framework conditions for ICT RTD in Turkey, ICT RTD infrastructure in Turkey, major centres of excellence, potential centres of excellence, Delphi analysis, brief policy network analysis, and policy recommendations at national, EU, and stakeholder levels.

The TEKPOL study shows clearly the standing of Turkish ICT research at the EU level, but it does not extensively question the impact of international collaboration on local buzz.

[1] http://stps.metu.edu.tr/ict-rtd-technological-audit-turkey accessed on 30 September 2013.

Previous literature on networks with the involvement of Turkish researchers mostly investigates the linkages within national boundaries rather than internationalisation dynamics. Other studies are primarily focused on linkages and relationships among different Turkish organisations themselves and local networks (Armatli-Koroglu, 2004; Erdil and Çetin, 2008; Erdil et al., 2008). In contrast to previous network studies, this thesis explores the involvement of Turkish entities in international R&D networks and, while linking it with the local base, also questions the local impact followed by such international knowledge exchanges.

Network literature implicitly treats researchers who are involved in different collaboration actions as gateways between different projects. Such researchers may also transmit knowledge gathered from international platforms to the local level, which can enhance the local buzz. On the other hand, rather than contributing to local knowledge spillovers, these gateways may serve to transfer local tacit knowledge into international forums, which may have limited or no positive effects on the local competitiveness level. As a third option, rather than acting as gateways bridging the local and the global, they may have limited local connections while preferring to interact mostly with global players and transmitting all of their gains from international collaboration projects to other foreign partners.

In light of these statements, the main research question of the thesis is:

- Does participation in international R&D networks create local buzz in Turkey?

This question is formulated within the framework of Turkish participation in EU FP6 IST projects and other international collaboration projects which explicitly support establishment of international R&D networks.

Four sub-questions arise in terms of differences in the significance of international and local collaboration:

- How can the profiles of participant Turkish ICT researchers be framed in terms of their significance in focus on local buzz and global pipelines?
- How can the differences or similarities in the degree of the global/local base be explained at the researcher level?
- How are leading Turkish universities constructing the mix of international versus local focus?
- What kind of policy implications can be framed in terms of the findings of the study?

Based on these questions, the major objective of the thesis is to develop a model, by using quantitative methods, to frame the local versus international orientations of the researchers. Moreover, by using qualitative approaches following the quantitative study, a set of key policy issues at the micro, meso, and macro levels are identified, which are related to managing the collaboration mix of researchers and also universities in the Turkish research ecosystem.

More specifically, this dissertation also tries to find answers for more detailed issues, as well. These issues are:

1. How can research portfolios of different researchers be compared in terms of their international and local orientations?
2. Do prior roots, background, and special ecosystems make differences in researchers' international and local portfolios?
3. What are the key enabling and limiting factors that have relations with the outputs of Turkish ICT researchers?

CHAPTER II

CONCEPTS, TRENDS, AND CONTEMPORARY LITERATURE ON INTERNATIONAL R&D NETWORKS

2.1. Innovation and Change

Today we face tendencies caused by ongoing transformations related to the declining cost of production, the spread of talent and markets, and the influence of information technologies. These emerging trends are conceptualised as a “flattening of the world” (Friedman, 2006). However, this view is not enough to explain the dynamics of our decade, because there is not sufficient evidence that global opportunities regarding access to the process of absorption and appropriation needed to create and use knowledge are equal for everyone. Therefore, it is more appropriate to say that the world is becoming more and more “spiky”, both in its economic activity and its innovation activity (Florida, 2005). For example, the database on patented innovations developed by OECD member shows that California, Massachusetts, northern Europe and Scandinavia, Japan, South Korea, and China are the spikiest points of the world. Unfortunately, much of the rest of world is completely blank and innovation remains extraordinarily concentrated (Figure 1). This picture clearly invalidates argument of Freedman (2006), whereby it is said that “"When the world is flat, you can innovate without having to emigrate”.

Under such conditions, innovation emerges as the essence of today’s razor-edge competition (Singh, 2009). Innovation is about perceiving the rising trends and blending them effectively with knowledge to gain competitive advantages. Innovations are brought about as a result of processing enormous amounts of knowledge, which requires a combination of scientific,

design, engineering, and operational knowledge from different sources; this is a hard skill for an individual or a single organisation to master alone. In other words, most innovations take place through interactions between different actors within the ecosystem. Such interactions lead networks to become the locus of innovation (Powell and Grodal, 2005).

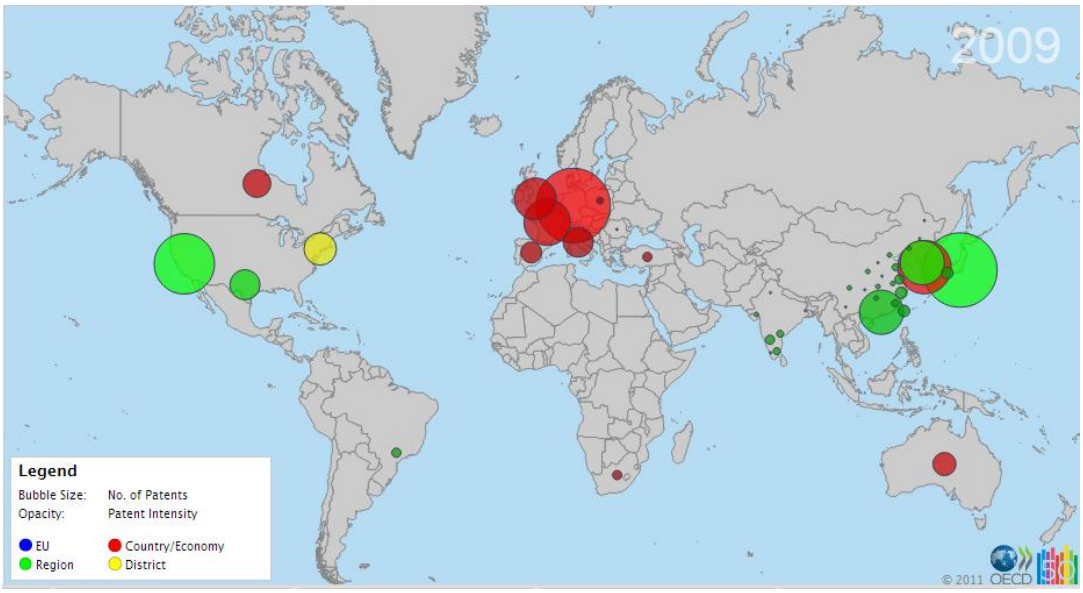


Figure 1: The number of global patents for states, provinces, and countries (Source: OECD, 2011).

Day by day, innovations require more complex processes, which are bounded by the knowledge intensity of the actors. Acquiring knowledge is not a matter of chance; it is a cumulative and path-dependant issue. This is true for the global knowledge-generation scene, as well. Global knowledge generation is highly structured with a small number of organisations dominating the entire landscape. The same can be argued for global knowledge flows, as well. These tendencies can be explained within the concept of a spiky world, which is a clear indication that knowledge flows are not flat and not random (Florida, 2005; McCann, 2008). Rather, knowledge distribution shows self-organising dynamics around power laws and preferential attachments. The same statement can be made for the networks generated under EU Framework Programmes, which have a path-dependent nature. Knowledge does not flow equally inside the networks.

Based on the background given above, this chapter is intended as a preparatory stage presenting the theoretical perspective of the thesis. It situates the contemporary discussions in network literature while providing room for the complex nature of today's world. This chapter also aims to challenge the empirical literature on EU Framework Programmes networks by arguing that more emphasis should be given to dynamics of local deployment of knowledge acquired through international collaboration.

2.2. The Complex Nature of Today's Connected World

In the first half of the past century, when Schumpeter identified creative destruction as an outcome of wild-spirited entrepreneurs, he remained unnoticed by many. Today he is undoubtedly seen as a guru who presented keys to unlock the black box of recent economic dynamics. Transforming Schumpeter's thoughts to today's world, it can be stated that creative destruction arises from those who integrate, produce, and own more knowledge than others. Pushed by the increasing complexity and multidisciplinarity of research, firms seek to access complementary resources beyond their boundaries (Apilo, 2004). Similarly, accelerated technological changes over the last decades have forced and still force many organisations to upgrade their technological competence levels in order to survive in global markets. In such a deadly race, the capability to develop new technologies is seen to be a major challenge. However, the knowledge needed to generate such technologies is highly differentiated and distributed. Therefore, creating links to access such knowledge is vital.

In this context, firms are pressed to act beyond corporate and national trajectories because organisations need more knowledge than ever before. Day after day, the self-sufficiency of in-house knowledge to find solutions for domestic problems is decreasing. Therefore, actors struggle to access external resources through technology transfer, knowledge accumulation, and learning. In this process, local collaborations tend to be replaced or dominated by global partnerships and innovative activities become somewhat

less dependent on home-country innovation systems. This is simply because of the enormous worldwide processing of knowledge and the necessity of knowledge variation for innovative activities.

It can be argued that knowledge capacity is the driving force behind the ability to be more powerful and more competitive (David and Foray, 2002). The ability to integrate different types of knowledge is indispensable for more complicated innovations. Such a tendency leads research to become more and more interdisciplinary. Under these circumstances, organisations rarely bring breakthrough innovations in isolation; they have to find ways to benefit from external knowledge and act beyond the traditional boundaries of the firm. This is mainly achieved with collective action, which is becoming a common source of new knowledge production and a vital element for new innovations.

Collaborative arrangements comprise many different types of actors including universities, research institutes, large organisations, and small and medium enterprises (SMEs). Gibbons et al. (1994) argue that this new mode of knowledge production ("mode 2") stems from the need for more socially accountable, applicable, and trans-disciplinary knowledge. It is not surprising that the biggest knowledge producers are the best-linked institutions that have the capacity and ability to acquire and integrate knowledge and to convert it to novel outputs. These are knowledge hubs that emerge as attraction centres to less-linked institutions, forming the peaks of the so-called spiky world.

The spikiness is related to absorption capacity. The concept of absorptive capacity refers to a firm's ability to identify, assimilate, and exploit knowledge from external sources (Cohen and Levinthal, 1990). The absorptive capacity is constituted by the abilities to acquire, assimilate, convert, and exploit knowledge and there are two types of absorptive capacity: potential (PACAP) and realised (RACAP) absorptive capacities (Zahra and George, 2002). According to Zahra and George (2002), PACAP makes a firm receptive to

acquiring and assimilating external knowledge. It captures the firm's capability to value and acquire external knowledge, but it does not guarantee the exploitation of this knowledge (Cohen and Levinthal, 1990). RACAP, on the other hand, reflects the firm's capacity to leverage the knowledge that has been absorbed. Absorptive capacity refers to an organisation's ability to acquire, assimilate, and exploit information (Kastelli, 2006). Similarly, Wagner (2006) states that "the question for developing countries is not how to get into collaborations with Germany, the UK or the US, but how to take applicable knowledge from the network (no matter where it is located), make it relevant to local needs and problems, and tie it down".

Spikiness is also related to innovativeness, which requires openness to collaboration. Innovation requires a combination of scientific, design, engineering, and operational knowledge from different sources, which is difficult for an individual or single organisation to master alone. This innovation-oriented progress cannot be achieved in isolation. It requires interaction with other actors (e.g., universities, research institutions, large science- and technology-based multinationals, high-tech SMEs, or standard setting organisations) within a framework of existing institutional rules (laws, norms, technical standards, etc.). It can be argued that in a knowledge-based economy, not only the creation of ideas but also the adaptation and diffusion of ideas is important (Wagner et al., 2004). In line with this argument, Schibany and Polt (2001) note that isolated firms rarely bring significant innovations to the market. Instead, firms generate innovation through interactions, ordinary or complex, with different actors within the firm's environment, where networks become the focus of innovation (Powell and Grodal, 2005).

To cope within the global economic structure and to gain a competitive advantage, the interplay of new knowledge and engagement in networks of collaboration is crucial. Hagedoorn and van Kranenburg (2003) argue that alongside traditional university-led research, new collaborative research arrangements have proliferated. Quite simply, the rules of the game have

changed. Under the new conditions of the game, a more innovative locus means a spikier position in terms of knowledge production. In this sense, knowledge generation through inter-organisational collaboration becomes practical with mechanisms like networks, which enable and facilitate knowledge diffusion through repeated interactive relationships.

In light of these trends, governments have stepped forward to support knowledge generation and network structures. Most countries and regions have introduced new mechanisms, including the necessary funding structures, to enable and ease collaborative knowledge production. Most have set objectives of transforming the country into a knowledge-based economy. It is typical to see governmental attempts to enhance the innovative environment through university spin-off firms, strategic alliances among firms, government laboratories, and academic research groups, as well as by fostering other initiatives for knowledge-based economic developments and ventures (Etzkowitz and Leydesdorff, 2000). At the root of this process is the desire of gaining a more spiky position on the global map of knowledge generation.

As mentioned before, collaborative networks are increasingly driving new developments in research and knowledge creation (Wagner et al., 2004). Thus, besides being vital coordination devices, networks are essential catalysers for new technological progress and development (Kuppers and Pyka, 2002). With a similar view, Borgatti and Foster (2003) sees inter-firm collaborations as responses to the conditions of asset specificity, demand uncertainty, task complexity, and frequency of interaction for organising knowledge production and exchange, which are features that we see in a more globalised world. Perhaps all of these network-type structures are forced by globalisation; however, it is important to note that the globalisation phenomenon itself is open to discussion. Being aware of this fact, I will not discuss the concept broadly, since it lies beyond the boundaries of this thesis.

2.3. Hubs in R&D Networks: Winners in the Spiky World

Thus far, we have placed the concept of knowledge within the boundaries of the globalisation process; it is primarily based on the spread of talent, capital and markets, transformations related to declining costs of production, and the rapid advances of information technology. Globalisation introduces new dynamics of competition, where determinants of competitiveness become much more complex and boundaries between national and international markets begin to blur (UNCTAD, 2005). This has also been portrayed as the "flattening" of access to resources. It is important to note that what has been described above is connected to outsourcing and the flow of financial capital. This approach cannot capture the complexity of all changes taking place, as the drivers and consequences are different for different knowledge-creating sectors (Wagner, 2005). There is no sufficient evidence that the opportunities of access to the process of absorption and appropriation needed to create and use knowledge are similar throughout the world. Globalisation provides more gains for those who learn more quickly and who accumulate and generate more knowledge than others. Therefore, it is more appropriate to say that the world is "spiky", both in its economic activity and its innovation activity, rather than being "flat" (Florida, 2005). Here, the crucial question is: Are these actors recruiting new knowledge through their external interactions with hubs? Or are institutions in the periphery pumping their local knowledge to spikier centres of action? The answer to these questions lies in inter-organisational interactions between the more developed world and emerging economies. Therefore, analysis of cases of research collaboration between developed country and emerging economy institutions will provide valuable insights to the questions. In fact, the relations between developed countries also shape the relations between the developed world and emerging economics in the context of the global division of labour.

In the spiky world, connectivity in networks is controlled by a few important nodes, or hubs, that tend to have a large number of ties; there is a higher probability that a new node will get connected to a node already exhibiting a

large number of connections (Protogerou et al., 2007). Barabási and Albert (1999) further state that in many real-world networks, some nodes have far more links than would be predicted if the number of links per node were randomly distributed. Similarly, Malerba et al. (2006) proved that relatively few European companies considered to be hubs dominated the IST theme of FP6.

Hubs are connectors that link many networks. They dominate the structure of their networks, and thus, in a way, they manage to structure their networks (Wagner and Leydesdorff, 2005). Real networks therefore seem to display more clustering than would be expected of random networks. A hub is an organisation in a specific network that has many links and/or connects the otherwise unconnected parts of the network.

Hubs within scientific networks are attractive collaborators (Wagner and Leydesdorff, 2005). According to Barabási and Frangos (2002), actors display preferential attachment: when choosing between two possible links, they will seek to connect to the better-connected option. Therefore, we can argue that when actors are seeking a collaborator, they will seek one that is already highly connected and, therefore, has access to resources and reputation.

Several studies highlight the importance of hubs as the key success factor in embedding industry innovation (Malerba et al., 2006). Several RTD policies, such as the Fin-Nano programme, encourage and support international networking and mobility while also linking national hubs of expertise to international networks, whereby it is assumed that connections with hubs allow participants to grow and to see the technologies that are being developed or exploited (European Commission, 2005).

2.4. Contemporary Collaboration Dynamics

In order to describe the roots of R&D collaboration in our decade, a Schumpeterian approach can yield useful insights. In the early works of Schumpeter on entrepreneurs, usually called the Schumpeter Mark I conception[2], entrepreneurs are treated as innovators who make things work in the domestic economy. Although entrepreneurs are seen as agents of change who create the basis for economic growth, they act individually and the creative destruction that they bring is based on their individual efforts. Therefore, in Mark I there is no focus on alliance formation behaviour of entrepreneurs or firms. Schumpeter Mark II, on the other hand, focuses on large firms with resources and capital to invest in research and development. In Mark II, which was based on observations of the US industrial structure after WWII, large companies handle R&D with institutionalised and routinised efforts with dedicated departments or laboratories specialised in R&D. With this approach, R&D collaboration is primarily realised inside the boundaries of the firm.

When we come to the dynamics of today's global economy, which may be called Mark III, it is widely accepted that innovation-oriented progress cannot be achieved in isolation. It can be also stated that, in contrast to Mark I and Mark II, isolated organisations rarely bring significant innovation to the market. Innovative organisations of the current decade tend to seek knowledge beyond their boundaries in the world of widely distributed sources (Schibany and Polt, 2001). In a dynamic environment characterised by rapid change and complex innovations, organisations are forced by their environment to design new R&D practices, including both internal organisational changes and openness to new collaborations, to deal with growing outsourcing and various types of technological partnerships. In relationships of such a complex nature, networks emerge as a new form of organisation for new knowledge production (Kuppers and Pyka, 2002). As

[2] Dosi et al. (1995) proposed a model in which two regimes, Schumpeter Mark I and Schumpeter Mark II, are respectively identified with "entrepreneurial" and "routinised" characteristics.

platforms that trigger interactions, networks play a central role in a knowledge-based economy where the adaptation and diffusion of ideas is at least as important as the creation of the ideas themselves (Wagner et al., 2004). Increased collaboration between firms enables them to better foresee market conditions, shaping the rate and direction of technological developments to a large extent such that the anticipated output of interactions among network members is a continuous knowledge flow and the organisation is characterised as a "dense collection of communication links" (Ozman, 2009).

In an era in which the interchange of knowledge plays a pivotal role, firms are exploiting externalities or "knowledge spillovers" through inter-firm cooperation in order to adapt and remain competitive. The concept of knowledge spillovers was defined by Griliches (1991) as "working on similar things and hence benefiting much from each other's research". Therefore, R&D collaborations can be used as a proxy for knowledge spillovers (Schibany and Polt, 2001). Due to fact that spillovers do not depend solely on knowledge and some competencies are also vital, the role of absorptive capacity is defined by such spillover effects. It can also be argued that knowledge spillovers occur among countries whether participants are taking the roles of R&D hubs or developing links with the already existing hubs (Güler and Kara, 2011).

One point that can be derived from the definition of knowledge spillovers is that proximity between organisations tends to increase the probability of spillovers; several scholars have contributed to the literature in this respect, covering agglomeration economics, regional innovation systems, and clusters. This thesis will not expand on that side of the issue, but will focus, instead, on knowledge networks.

The importance of innovation, and high R&D costs, have given rise to the duality of cooperation and competition (UNCTAD, 2005). It is now usual to see rivals within the same collaboration network. For example, in the MERIT-

CATI database, the proportion of “R&D partnerships” in pharmaceuticals and information technologies increased from 40% to 80% of the total between 1980 and 1998 (Hagedoorn, 2002). Innovative networks are, thus, usually too complex to be reduced merely to value-added chains (Dumont and Tsakanikas, 2001). Instead of supplier–buyer linkages, which are vertical linkages, horizontal linkages are favoured at governmental and supranational levels such as the EU Framework Programmes, COST, and EUREKA. All of these mechanisms aim to enhance collaboration beyond supplier–buyer linkages.

Thanks to supranational organisations such as the EU, OECD, and UNCTAD, today it is widely believed that the underperformance of a research system can be partially attributed to poor networking between researchers, research institutions, and science and industry (Görtz, 2005). Promotion of collaboration through networks constitutes the dominant approach to invigorating innovation in national innovations systems. For example, in order to overcome failures in research systems, the promotion of collaborative R&D has become one of the top priorities of science and technology policy design in industrialised countries (Caloghirou et al., 2002).

Besides the tendencies at the firm level, growth in international collaborations among scientists is heavily seen in the era of globalisation. Wagner and Leydesdorff (2005) found that research networks arise from the strategic behaviour of researchers that “link together in search of rewards, reputation, and resources offered by a collaborative network”. They found that the enhancement of international collaborations in science is due to mechanisms of preferential attachment based on reputation and rewards. Similarly, Laudel (2002) identified different types of research collaborations that arise due to the horizontal specialisation of researchers, e.g., division of labour, service collaborations, transfer of know-how, provision of access to research equipment, and mutual stimulation. Additionally, indicators such as publications show that the amount of networking between different segments of the world, such as between researchers in advanced and developing

countries, is rising (Wagner et al., 2001). The crucial issue that needs deeper elaboration here is the direction and weight of knowledge flows in collaborations between researchers in advanced countries and developing countries. Is more knowledge diffused from advanced countries to the developing world, or vice versa? It is important here to mention an anecdote from Freeman (2005), where he asked a Harvard physicist, whose most important work was done collaboratively with overseas scientists and engineers, “So you are helping them catch up with us?” The scientist replied: “No, they are helping us keep ahead of them”.

2.5. Why Do Organisations Enter into Networks?

Today, network studies are treated as a panacea in fields from economy to sociology for putting forward basic problems and solutions. Every year, several hundred papers on the analysis and modelling of networks are published in different fields ranging from physics to mathematics, from computer science to biology, from economics to sociology journals, often with an interdisciplinary interest (Newman, 2003; Ozman, 2009). In this study, while recognising the greater width of the subject, I will only focus on research networks from economic and sociological perspectives.

Simply, research networks are about knowledge. They cover the interactions that enable, facilitate, or manage the production and/or application of scientific knowledge. As an engine for innovation, knowledge flow is the major outcome of the inter-organisational collaboration that takes place between different actors (Ozman, 2009). Therefore, as part of the efforts to unlock the complex nature of the so-called knowledge-based economy, networks are understood to be the ideal structures for learning about the dynamics of knowledge production and its flow between different agents.

The empirical analysis that explores the underlying motives for firms to collaborate with each other has highlighted a long list of potential drivers for research networks. Bayona et al. (2001) argued that the search for

technology is a major motivation for R&D cooperation. Similarly, Miotti and Sachwald (2003) state that firms engage in R&D cooperation in order to complement their internal resources and accordingly team up with partners who control the relevant complementary resources—which are not necessarily frontier technologies. Thus, the necessity for complementary resources is a key driver of inter-organisational research collaboration.

According to Ozman (2009), the knowledge base of the industry, uncertainty in the environment, similarity in knowledge bases, and the stage of the firm in its life cycle are all factors that affect the choice to enter into an alliance. Ozman (2009) also states that firms form alliances not only because they lack resources and organisational learning or because of strategic considerations, but also because they are embedded in social networks that influence the way they select partners. Similarly, Powell et al. (1996) state that firms network with each other not only because they lack resources and need to access others, but because they seek to explore and exploit knowledge bases.

Caloghirou et al. (2003) list several drivers for collaboration:

- R&D cost sharing;
- reduction of R&D duplication;
- risk sharing, uncertainty reduction;
- spillover internalisation;
- continuity of R&D efforts, access to finance;
- access of complementary resources and skills;
- research synergies;
- effective deployment of extant resources, further development of resource bases;
- strategic flexibility, market access, creation of investment ‘options’;
- promotion of technical standards.

Oliver (1990) reveals six motives for collaboration:

- meeting legal or regularity requirements;
- exercising power or control over another organisation;
- the need for reciprocal relations in the form of collaboration and cooperation rather than the exercise of power;
- increasing the organisation's internal input–output ratio;
- responding to environmental uncertainties;
- improving the reputation, image, or prestige of the firm.

In all of these cases, which are generally pragmatic and rational, one common issue is the circular flow of knowledge among actors in a network. There is no one-way move of knowledge between actors where interactions exist. Such reciprocal relationships are fuelled with continuous feedbacks, which are nonlinear in nature, starting from the emergence of a network. Although the network literature paves the way for the self-organisation process of networks, it is important to note that networks do not emerge by chance; they are mostly built on path-dependant, on-going interactions. While path dependency contributes to cognitive proximity and knowledge flows, it also harbours the risk of over-embeddedness, which may result in lock-in.

While knowledge is flowing in a circular manner, it does not flow equally between two actors. As Oliver (1990) states, an organisation that is at the core may attempt to exercise power or control over the periphery via acting to integrate or transform the local knowledge of other organisations. On the other hand, the organisations at the periphery may not benefit from the knowledge flowing around when the core does not exercise power, which may be attributed to a lack of absorption capacity of organisations at the periphery. These alternatives of knowledge flows and acquisition inside networks blur the definition and measurement of network performance. The performance of a network may be different from the perspectives of core and periphery institutions; however, recent literature attempts to assess network performance from a holistic perspective, neglecting the fluctuations at a core or a peripheral institution level.

2.6. Learning as an Outcome of Research Networks

It is widely accepted that external knowledge is essential for the innovation process (Cohen and Levinthal, 1990), such that outside knowledge is recruited mostly via interactions between agents. Research networks provide ground for such interactions among their nodes. The literature supports the idea that organisational learning is enhanced by collaboration (Powell et al., 1996).

Interactions trigger actors to learn from each other, such as interactions among the partners of a research network. Inter-organisational collaboration enables organisations to develop their absorptive capacity (Cohen and Levinthal, 1990), increase their skills to manage cooperation, and increase their awareness of new developments and possible further collaboration possibilities, as well as helping them to develop a reputation as a valuable partner (Powell et al., 1996). Learning can take place as a result of the knowledge diffusion across the partners of a network and the internalisation of that knowledge (Powell et al., 1996). Learning depends on the firm's ability to value, assimilate, and utilise new external knowledge, which is called absorptive capacity, and also on other network partners' willingness to share knowledge. Powell et al. (1996) also argue that organisational learning is both a function of access to new knowledge and the capabilities for utilising and building on such knowledge.

Learning refers to the internal processes of acquiring new skills, norms, values, and new ways of thinking within inter-organisational collaboration, such as learning to use particular theories or technical infrastructures, or new ways of solving problems arising in the course of research (Nokkala, 2009). Hagedoorn and Duysters (2002) argue that the effect of networks on learning depends on the type of network; learning through exploratory networks is better for innovative performance than learning through exploitation networks. Similarly, Anand and Khanna (2000) find that the effect of learning on value creation depends on the type of alliance. Dyer and Nobeoka (2002)

study how the vertical linkages in the Toyota network enhanced the organisational learning of its members.

In a dynamic capabilities framework, the knowledge bases of firms change over time (Ozman, 2010), which can occur through internal means as firms carry out R&D activities to increase their absorptive capacity (Cohen and Levinthal, 1990) or through external means as firms explore and exploit knowledge lying outside their boundaries. The majority of countries still rely more heavily on domestic R&D than on imported knowledge. Therefore, what can be learned has a path-dependent nature and is affected by what is already known; abilities to acquire, assimilate, connect, and exploit knowledge are decisive in learning.

Capacity building is, thus, a crucial topic for more enhanced knowledge diffusion, while how to take applicable knowledge from the network (no matter where it is located) and make it relevant to local needs and problems is another important challenge. While more effort is generally allocated to internationalisation, the national level is important for putting into place policy instruments to enhance absorptive capacity. Wagner (2006) and Tsai (2001) find that it is the interaction between the absorptive capability of the firm and its network position that has a significant effect on innovative performance. In that sense, developing mechanisms to pump knowledge obtained from global networks into the local ecosystem is an open area for further investigation.

Although the dominant view is that networks enable firms to learn from each other and explore new knowledge, there are studies that mention the risks associated with inter-firm learning. For example, Mohr and Sengupta (2002) find that inter-firm learning can direct the transfer of internal skills, which can dilute the competitive advantage. Therefore, there is a need to assess both the benefits and risks in collaborative relationships.

2.7. Evolution of EU Framework Programmes in a Spiky World[3]

As a platform to create links for knowledge generation, the European Framework Programmes can be seen as an attempt for leveraging the spiky world.

The European Research Area was formed after a 20-year discussion with a strong intellectual background. Starting from the early 1990s, network policies became very popular at the European level, in particular in reply to Japanese policies (DeBresson and Amesse, 1991). Ironically, Japan originally took its networking policies from western countries after WWI, when Cooperative Research Associations were established in the UK (Freeman, 1991) and then copied by France, Germany, and many others. Such research associations were thought to be mainly a device for overcoming market failure in industries where the threshold costs of R&D were too high, and they were activated in the fields of testing facilities, pilot plants, and prototype development.

The Japanese imitated these European developments much later (DeBresson and Amesse, 1991). The act passed in 1961 to set up Engineering Research Associations (ERAs) envisaged cooperation between government laboratories and various makers of parts and components, especially in the automobile industry (Freeman, 1991). Consequently, from the 1970s onwards, Japan has moved rapidly to increase its share of the world's science and technology production.

The apparent success of ERAs and the Japanese way of innovating (Dore, 1988) led to widespread imitation of that technique of organisation and funding, both in Europe and the United States, in the 1980s (Freeman, 1991). At that time, EU firms were supplying only 40% of their own market and 10% of the global market (Peterson, 1991), and debate of a technological gap began to emerge in Europe.

[3]Adapted from Güler and Kara (2011).

The first important step towards the transition to a rationale based upon support for industrial competitiveness followed the appointment of Viscount Davignon, a Belgian with considerable industrial experience, as the Commissioner responsible for the internal market and industrial affairs from 1977 to 1981 and for both industry and science and technology from 1981 to 1985 (Georghiou, 2001).

In 1980, the Commission convened a meeting of senior managers from 10 companies to discuss the future of the European information technology industry. This, in turn, led to the establishment of a roundtable, now consisting of 12 large companies, at the end of 1981, supported by a body within the Commission, the Information Technologies Task Force–Big 12 Roundtable (Peterson, 1991). The roundtable strongly endorsed the Commission's concerns for the sector and brought pressure upon their national governments to support the launch of the pilot phase of the ESPRIT programme, a collaborative R&D initiative in the field of information technology. This became the archetype for future industrially oriented programmes of the EU (Georghiou, 2001). The EC funds up to 50% of approved ESPRIT projects, which includes firms from at least two member states (Peterson, 1991). The fundamental feature of ESPRIT was the basic "pre-competitive" rationale, whereby companies would cooperate only in research that was sufficiently far from the market and would remain free to compete with their erstwhile partners at subsequent stages (Georghiou, 2001).

The success of the Big 12 Roundtable in influencing the design and management of ESPRIT inspired large non-IT manufacturers to form a similar group. The Gyllenhammar group brought together 20 leading manufacturers. The combined weight of the Gyllenhammar group and the Big 12 shaped the second phase of ESPRIT (Peterson, 1991). Several features of the early stage of ESPRIT were replicated for all industrial involvement in the Framework Programmes.

It was with the passing of the Single European Act (SEA) in 1987 that EU policy in research and technological development was fully established. The overall objective was to strengthen the scientific and technological basis of industry and thus lead to the increased global competitiveness of European Community countries (Georghiou, 2001). Article 130f of the SEA established that the policy would be implemented via a Framework Programme. The 1992 Treaty on European Union (Maastricht Treaty) continued with the ideas of coordination and cooperation and strengthened the Framework Programmes by making them the umbrella for all RTD actions of the Community. The Fourth Framework Programme (1994–1998) was established on this rational.

Following that, the "European Paradox" (Caracostas and Muldur, 1998) was realised, whereby European scientific performance in relation to investment in science is excellent but technological and commercial performance has steadily worsened since the mid-1980s. The EC endorsed the Fifth Framework Programme (1998–2002) based on that paradigm.

At the meeting of the European Council in Lisbon in March 2000, an ambitious objective of becoming "*the most competitive and dynamic knowledge-based economy in the world*" by 2010 was set (European Commission, 2000). As a platform to create links for knowledge generation, recent European Framework Programmes can be seen as an attempt for leveraging the Lisbon objectives. There are many other high-level documents that stress the importance of knowledge creation and strengthening the links among the actors of the European Research Area. For example, as observed above, the Presidency conclusions of the Spring European Council of 2006 recognised

> *"the need to invest more in knowledge and innovation, and the need for a comprehensive approach to innovation policy, including support for markets of innovative goods and services and excellence in research in new technologies, including ICT*." (European Council, 2006)

In the year 2000, the European Commission started to question the Europe's ability in the transition to a knowledge-based economy (European Commission, 2000). The underachievement of the EU was linked to the lack of a coherent European policy on research, and the proposed solution was the establishment of a "European Research Area", which set the ground for the launch of Sixth Framework Programme (2002–2006).

Some scholars argue that "EU cost subsidies may be counterproductive to knowledge sharing and patent subsidies could be more effective" (Pérez-Castrillo and Sandonís, 1997), while others suggest that "the FPs have been instrumental in keeping Europe in the technological race" (Dumont and Tsakanikas, 2001). Although the efficiency of the European Research Policy and EU Framework Programmes is debatable, the EU Framework Programmes have gradually become the driving force behind the formation of dynamic networks. In light of that standing, the Seventh Framework Programme (2007–2013) was designed to build on the achievements of its predecessors towards the creation of the European Research Area and carry it further towards the development of a knowledge economy and society in Europe (European Commission, 2005).

Collaboration projects constitute the building blocks of networks, which are a methodological tool for analysing integration in European R&D (Nokkala et al., 2008). There are many high-level documents that stress the importance of knowledge creation and strengthening the links among the actors of the European Research Area. For example, the Presidency conclusions of the Spring European Council of 2006 recognised "the need to invest more in knowledge and innovation, and the need for a comprehensive approach to innovation policy, including support for markets of innovative goods and services and excellence in research in new technologies, including ICT. It recommended that links should be strengthened between research and development, innovation systems and the business environment to improve the effectiveness of the innovation process". In particular, the two most

recent European Framework Programmes were designed to enhance the competence level of Europe considering the challenges of a spiky world.

Summarising these historical developments and looking from a more holistic viewpoint, four features of EU-level research (Polt et al., 2006) can be identified as follows:

Table 1: Four features of EU-level research and their potential values adapted from Polt et al. (2006)

Feature	Proposed Value
Pool and Leverage	Scale and complexity such that no member state can provide the necessary financial or personnel resources
Integration	Catalytic effect in terms of coordination of national initiatives
Human Capital and Mobility	Development of a genuine European research labour market
Knowledge Dissemination	Transfer of knowledge and skills across EU regions

2.8. Empirical Literature on Research Networks Formed under EU Framework Programmes

Like collaboration networks themselves, the empirical literature on research networks formed under the EU Framework Programmes is growing. Evaluating the RTD and innovation systems is one of the top areas of current science and technology policy literature[4]. On the other hand, the accuracy of these evaluation techniques is debatable. For example, Aho et al. (2006) states that current evaluation techniques have a tendency to undervalue the contribution of R&D. In line with this, Wagner et al. (2005) state that since

[4] "Workshop on Evaluation of Public R&D Funds", organised by TÜBİTAK, presents the recent literature on R&D programme evaluation (Retrieved from http://www.tubitak.gov.tr/tubitak_content_files//BTYPD/DKF/DKF-Degerlendirilmesi_Rapor_Part2.pdf on 30 September 2013).

collaborative networks are a central policy goal of EU RTD policy, it makes sense to apply and refine tools to measure and assess these networks. Similarly, Breschi and Cusmano (2004) underline the importance of assessing the impact of network approaches. Considering these recommendations, the European Commission promoted several evaluative and project-based studies to further develop the understanding of the structuring effects of FP ICT networks, their positioning in global ICT research networks (i.e. their international reach), and the linkages between research, innovation, and ICT deployment activities and regional systems of innovation (European Commission, 2008). Below, some important points from those studies are highlighted.

Breschi and Cusmano (2004) analyse the structural characteristics and dynamics of the EU-wide R&D networks with projects funded by FP3 and FP4. They state that different organisations play a fundamentally different role in the R&D network: for example, organisations that participate only occasionally in R&D consortia contribute little or nothing to the networking activity taking place in the project network; on the other hand, most networking activity seems to take place between project coordinators. Similarly, Wagner et al. (2005) argue that the self-organisation in the ERA system is disturbed by the selection process. They point out that large companies and research institutes were more dominant in the 6th Framework Programme; as central institutions in many projects, some large companies act as “gatekeepers” through their choices of first tier partners. On the other hand, in a paper examining the collaborative networks formed in the ICT field under the 4th, 5th, and 6th EU Framework Programmes, Protogerou et al. (2007) argue that the networks formed in the context of Framework Programmes are the result of self-organised partnering by participating entities.

In their study[5] to identity the key properties of the EU R&D collaboration networks, Roediger-Schluga and Barber (2006) state that there is a significant tendency for the same organisations to participate in successive Framework Programmes and that there is persistent collaboration between the same organisations within different Framework Programmes. Furthermore, in an analysis of organisations that participated more than 30 times in FP1–FP5, they found that there was a tendency for organisations to build long-lasting collaborative links in the Framework Programmes, especially amongst a smaller group of key actors, which is coupled with an increased clustering of those organisations over time. A study by Protogerou et al. (2007) also indicates that FP networks appear to exhibit similar topological characteristics within the network that was formed by the research projects of the 3rd and 4th Framework Programmes, where it seems that they are strongly dependent on a core of central actors. Other findings of Protogerou et al. (2007) are as follows:

- Organisations that established connections in early FPs become more connected and central through their repeated participation and the mechanism of preferential attachment.
- The quantity and quality of the knowledge creation process and its diffusion within the network is dependent on the resources and technological capabilities deployed by these core actors.
- The role of prominent actors in the three FP networks is highly influential, but there are other less focal organisations, such as organisations from new member states and associated countries, which may bring fresh ideas and the new resources essential for the creation of innovative outputs. The issue of knowledge flows among old and new actors of FPs needs further investigation.

[5]The study is based on EU Framework Programme data between the years 1984 and 2001.

Likewise, Nokkala et al. (2008) state that prior collaboration is an important stock of social capital for coordinators seeking to establish a project consortium, and also for potential partners in accepting the invitation to join a consortium.

The EU networks have shown themselves to be highly durable, with cooperation both between individual researchers and between research institutions continuing after the initial joint projects (Georghiou, 1998; Caloghirou et al., 2002; Barber et al., 2009). Furthermore, the clustering of organisations seems to have increased over time (Roediger-Schluga and Barber, 2006).

The results of Breschi and Cusmano (2004) indicate that the EU R&D collaboration network is quite dense, with the density decreasing over time as more organisations join the network and new links are created between existing organisations, such as inclusion of new member states and candidate countries. A similar finding of the study is that organisations involved in R&D consortia tend to introduce pairs of their collaborators to each other, which triggers new collaborations among previously unlinked actors. In line with these arguments, in a study focused on funded IST projects, Wagner et al. (2005) state that participation in an EU Framework Programme was instrumental in connecting universities and businesses, connecting research in different themes and disciplines, and integrating new member states, patent holders, and SMEs.

The study by Breschi and Cusmano (2004) also found that a very large number of organisations have a very small number of direct links with other organisations, but there is a fat tail of organisations with a very large number of connections. Malerba et al. (2006) similarly showed empirically that EU ICT RTD networks are governed by knowledge hubs, where a hub is defined as an organisation in the top 2% of the best performing organisations in FP6 IST sub-field. In other words hubs dominate the network linkage that their

removal would fragment the network to such a degree that the largest remaining component would be only one-third of the size.

In a complementary work, Malerba et al. (2007) attempted to assess the effectiveness of collaborative networks and of knowledge transfers between research, innovation, and deployment activities related to IST at the EU and regional levels. The study highlights the influences of linkages between the research networks built through FP6 IST's "Applied IST Research Addressing Major Societal and Economic Challenges" sub-theme on the one hand and the deployment networks built through eTen, eContent programmes, structural funds, and other regional funds on the other hand. The analysis is based on social network analysis, complemented by field interviews, to enhance and support IST monitoring and evaluation procedures as they relate specifically to the research and deployment activities within projects supported by both EU and local funding.

In their analysis and modelling of the structure of R&D networks, Roediger-Schluga and Barber (2006) assume that all partners in an EU project collaborate with each other with equal intensity, i.e. the projects are interpreted as fully connected sub-networks of participants. This is an issue open for further discussion because studies like those of Nokkala et al. (2008), Protogerou et al. (2007), and Wagner et al. (2005) state that EU R&D networks are based on preferential attachment, which challenges the idea that those networks have a self-organising nature. For example, Nokkala et al. (2008) state that there is an overestimation of existing relations within an EU project, and thus they reject the assumption that all partners in an EU project collaborate with each other with equal intensity.

Protogerou et al. (2007) state that EU R&D networks are mainly collaboration activities for pre-competitive research, which covers different stages of the innovation process compared to networks formed by alliance data, patents, patent citations, or scientific publications. Focused on the specificity of EU R&D networks, Nokkala (2007) seeks to answer what motivates individuals

and organisations for collaboration or non-collaboration with certain partners, and how knowledge production and inter-organisational learning take place in inter-organisational collaboration projects such as EU Framework Programmes. With a sample consisting of nine cases from FP6 NEST projects, the study provides insights about the dynamics of network formation and knowledge production at the grassroots level by focusing on the micro-scale project network, its individual and organisational participants, and the ties between them. Nokkala performs in-depth analysis of the individual collaboration paths, motivations, expectations, and interactions.

With more of a micro-level view, Nokkala et al. (2008) try to understand the linkages of communication and joint knowledge production between partners within different EU-funded R&D collaboration projects. Analysing intra-project linkages from Integrating Projects (IPs), Small or Medium Scale Focused Research Actions (STREPs), and Networks of Excellence (NoEs), Nokkala et al. (2008) attempt to identify the drivers for partner choice in current and future EU Framework Programme projects. They find that prior collaboration between partners, characteristics of the partners, and the formal status of the partners in past or current collaborative projects play an important role in partner selection.

In order to study intra-project linkages, Nokkala et al. (2008) draw from three different sets[6] of quantitative and qualitative data, covering different thematic priorities and programmes, as well as different funding instruments within the 5th and 6th Framework Programmes. They perform both quantitative and qualitative analysis, where desktop research is coupled with an in-depth analysis of the individual collaboration paths, histories, motivations for cooperation and non-cooperation with specific potential partners, and descriptions of interaction within the projects. The dataset includes 22 in-depth qualitative interviews with actors from seven funded research projects. For all projects, the coordinator and at least one work package leader were

[6] A set of projects from the FP6 NEST programme, a set of Integrated Projects in FP6, and a survey of FP5 participants.

interviewed, but managers, ordinary participants, and subcontractors representing universities and research institutes were also included when possible.

All of these studies allow for rich analyses from different sides. However, since they (except for Nokkala et al., 2008) are based on the supra-nationality concept, they mislead in regard to the impact at the organisational level and the impact to the ecosystems of the partner organisations. While Malerba et al. (2006) focus on global pipelines, their study does not examine local buzz dynamics. Studies also underestimate the importance of dynamic capabilities. Therefore, I propose that there is a need to focus on the dynamics of the organisations at the research team level in order to observe the exact impact of the project(s).

The fact that each sub-programme of the FPs is organised under several thematic priorities (for example, the IST Programme in FP6 is organised into 23 thematic priorities[7]) requires a combination of different evaluation techniques. While some parts of the generic effects can, for instance, be covered with a standard questionnaire, the types of outputs and impacts will vary considerably between projects with different strategic objectives (e.g., those aiming at societal goals such as e-Inclusion, those with strong infrastructural output components such as ‘broadband for all’, and those with a higher share of privately appropriable results such as ‘embedded systems’) (Polt et al., 2006).

FP networks are mainly formed at the pre-competitive stage. In the case of the automotive industry, the European Commission stated: “Research must be at the pre-competitive stage, which means that the products obtained from it may not be directly usable in a specific type of vehicle. Examples of acceptable research projects would be those relating to the use of ceramics

[7]Similarly, the concentration of Turkish partners is diversified in 19 fields of ICT.

in engines or aimed at limiting noise or emission pollution caused by motor vehicles"[8].

Another feature of EU-funded networks is that there are different roles played by the network members. Different organisations fill different positions such that there are diversified roles in networks, where the best-positioned institutions see better gains than the other members. At this point we can speak about power relations in networks, where the centrality of a network is measured via eligible costs. Collaboration experiences in previous FP-funded projects are valuable references for partner choice (Nokkala et al., 2008). This means that the institutions that receive more money from the Commission are better positioned in EU networks and control the knowledge flows in those networks.

Knowledge production occurs primarily in work packages where communication is facilitated by the small size of sub-structures of EU collaboration projects. We know from the network literature that highly connected, strongly tied networks are better suited for the diffusion and exploitation of existing knowledge, while weakly tied networks are better suited for the exploration of new knowledge. In FP projects, joint knowledge production takes place within the work packages (Paier, 2006). This means that all partners in a network are not equally connected and knowledge is not flowing equally to each cell of the network within a collaboration project. Moreover, knowledge flows in FP-funded networks are mediated by project coordinators and other sub-leaders (i.e. work package leaders and task leaders). However, a lack of research to understand the internal dynamics of collaborative research projects funded by the EU Framework Programmes prevents us from commenting further on knowledge flows inside the networks.

[8]"Commission backs R&D agreements in the motor industry", http://europa.eu/rapid/pressReleasesAction.do?reference=IP/98/832&format=HTML&aged=1&language=EN&guiLanguage=en, accessed on 30 September 2013.

Another area that needs further investigation is the reciprocal relationships among partners of an EU-funded network, which could give us insights about the factors that, prevent or motivate knowledge flows inside a network.

Breschi and Cusmano (2004) suggest that organisations participating in only one project contribute little to the networking activity taking place within EC-funded research. It can be argued that the strength of networking may change from project to project with respect to the role accomplished in FP6 IST projects, and the argument of Breschi and Cusmano (2004) about this can be challenged. This implies that in-depth analysis should also be employed, rather than quantitative analysis alone.

Although there is considerable willingness for collaborative partners to forge durable formal collaboration links, there seems to be considerable variation in the extent to which the formal links translate to shared knowledge production within the projects. Intra-project communication is essential for shared knowledge production (Nokkala, 2009). However, literature on EU-funded networks fails to show how all of these experiences gained at the supranational level can be transferred to the local level.

While networks can provide effective pathways for knowledge creation[9] and knowledge flows, not all networks are equally effective (Barabási and Frangos, 2002). Polt et al. (2006) further state that in a programme that comprises 23 objectives and variety, the impacts cannot be handled with one-size-fits-all surveys. Based on the work of Nelson and Winter (1982), it can also be argued that organisations own their unique habits and routines,

[9] New knowledge can take several forms: it may be embodied in human resources or capital, or it may take the disembodied form of new best practices, which leads to a more efficient deployment of existing resources. The benefits of the new knowledge may be directly and fully captured by the entity supporting or performing the RTD; it may spill over to benefit other parties. The economic benefits of the new knowledge may be fully captured and measured in the benefit-cost calculations of private actors (e.g., rates of return); however, because of spillover effects or market conditions, divergences may occur between private and social benefits. New products and processes introduced as a result of RTD may rapidly and extensively diffuse through the marketplace; alternatively, market penetration may be slow and limited.

which directly affect their local buzz as well as their links with global knowledge pipelines and, thus, their performance in international collaboration networks. Therefore, it is important to design a mechanism that will work to understand the dynamics of the system that nurtures the collaboration process for each team[10] and to explore the hidden parts of every network that give insights to their operation and effectiveness (Wagner and Leydesdorff, 2006). Based on this, it is obvious that generalisation and construction of a model that is based only on quantitative data analysis can prevent us from more closely viewing and fully understanding the knowledge creation process as it happens. Moreover, rather than putting all successful organisations in the same symbolic basket and treating them with the same indicators, it is more fruitful to deepen the focus on each organisation separately.

Beyond these macro-studies at an EU level, there has been no broad attempt to study the impact of Framework Programmes on the Turkish innovation system, except for the study of Güler and Kara (2011). Instead of constructing a framework to judge the impact of the programme, most of the discussions in the academic, business, and political spheres were based on "profit and loss accounts", which is the reflection of input–output orientation for assessing R&D programmes[11]. In such an approach, it is believed that if the government puts adequate money into the basket, it will generate outputs in which the innovation process is not seen, known as a "black box". It is obvious that if we do not know how the innovation process works, we will not be able to assess how increased R&D contributes to innovation in either the economic or the social sphere (European Commission, 2008). Therefore, it is important to unlock the inside of the "black box" in order to develop effective evaluation and impact assessment tools.

[10]Here it was preferred to focus on teams rather than organisations, because an organisation may consist of several teams that are active in FPs. Another argument for this approach is that there are recent discussions stating that more and more incentives should be opened for teams rather than organisations.

[11]In Turkey, this is summarised with the approach of "How much has been given to Brussels, and how much has been received from Brussels?"

Moreover, there is a need for a paradigm shift in Turkish society to embrace a contemporary approach in place of "black box" models in assessing the benefits of R&D programmes. It is thought that involvement in European Framework Programmes provides not only financial support for conducting collaborative research projects, but also enhances new knowledge generation and diffusion, increases learning and dynamic capabilities, and integrates the partner organisations into global R&D pipelines, all complementary to local buzz. The local buzz–global pipeline approach emphasises both the need for close local networks and strong extra-local or global linkages (Maskell et al., 2006). However, these claims need evidence-based justification.

The involvement of organisations from emerging economies in pre-competitive international R&D collaborations is also an area that needs to be unlocked. It is important to expose the dynamics of networks with involvement in the emerging world, where institutional linkages, knowledge creation, knowledge deployment, and the impact on the country's research and technology development capability all need further investigation. Therefore, the dynamics of successful organisations[12] need to be analysed. As will be mentioned later, this heterogeneous mix of evaluation (Wagner et al., 2004) .will play a different role and provide useful insights.

There are some studies on networks with Turkish involvement; however, they explicate the national dynamics involved in collaboration networks rather than internationalisation dynamics. They are mainly focused on the links and relationships among different Turkish organisations and networks[13]. In contrast to previous network studies, this study explores the involvement of Turkish organisations in international R&D networks. An attempt to

[12]A "successful" organisation is an organisation that is involved in STREPs and IPs under the FP6 IST Programme.

[13] For example: *Innovation and Relationships in an Organized Industrial District-Ankara Sincan Industrial District* (Erdil and Çetin, 2008); *SME Networks as New Engines of Economic Development and Innovation* (Armatli-Koroglu, 2004); *Kümeler, Sanayi Aglari ve Inovasyon: Ankara Bölgesi Makina ve Mobilya Sektörleri Örnegi Projesi* (METU TEKPOL, 2008).

investigate the involvement of Turkish organisations in pre-competitive international R&D collaboration networks and to examine the impact of that involvement on the country's research and technology development capability is thus relevant. Additionally, previous studies on international R&D collaboration have mainly focused on international R&D collaboration linkages between developed country organisations themselves. The present research diverges from that trend in an effort to deepen the focus on the dynamics of developing country organisations in international R&D collaboration networks, which are dominated and usually led by developed country organisations.

2.9. Bridging Networks Literature with Local Buzz–Global Pipelines Phenomenon

Knowledge is the cement of innovation. Studies bridging the concept of knowledge with innovation patterns have attracted great interest from the academic community in the last 20 years. The same can be argued for the positioning of innovation policy in economic development literature, where it is attracting attention from politicians and policy-makers at all levels. Especially from the point of view of economics and the social sciences, understanding how R&D-oriented entities and research groups organise the knowledge creation process in "the globalising learning economy" is an interesting area for research, because it is not easy to directly link one issue with another within the boundaries of different innovation theories (Archibugi and Lundvall, 2002).

Innovation is primarily characterised by uncertainties, high risks, and unpredictable returns on investment, which make it a nonlinear and complex process (Rosenberg, 1982). Since it is not a process that is easily unlocked, the research on innovation dynamics has been handled from different approaches.

One of these approaches links technological innovation dynamics with perspectives of economic geography and spatial economics. In line with this perspective, I discussed the concepts of a flat versus spiky world in previous sections of this thesis.

The way of handling globalisation versus localisation or flattening versus spikiness is affected mainly by the political sphere. Such controversial approaches to economic geography and spatial economic are clarified by Christopherson et al. (2008) as follows:

> *"Everyone agrees we live in a more 'globalized' world, but views differ as to what this means and whether it is a trend for good or ill. Those on the neoliberal right are typically pro-globalization, arguing that it has opened up markets across the globe, that it is a force for spreading opportunity and wealth across nations and that the intensification of competition it engenders stimulates innovation and productivity. Those on the political left tend to be anti-globalization, arguing it is a process dominated by global corporations that have become more powerful than nation states, that it increases inequality within advanced economies and undermines the ability of the world's poorer countries to improve social welfare or protect their natural environment"* (Christopherson et al., 2008, p. 1).

Castells (2011) states that globalisation forces changes in our understanding of spatial concepts, assuming that anything can be located anywhere and thus moved somewhere with ease. Similarly, there are many studies that state that "innovation takes place in international networks reaching far beyond their region's boundaries" (Benneworth and Dassen, 2011).

Dominance of approaches favouring the international dimension of innovation creates a challenge for regional policy-makers. On the other hand, the role of the local ecosystem as an important knowledge base to enhance local firms' capabilities of gaining advantageous positions in the global market has been widely recognised under concepts such as regional innovation systems, industrial clusters, localised learning, and innovative milieus (Porter, 1993; Freeman, 1995; Cooke et al., 1997; Malmberg and Maskell, 2006).

Besides the black and white sides of this debate, there are empirical analyses that exhibit trends towards both increasing globalisation and localisation (Trippl et al, 2009). Similarly, the necessity for both strong local and global interactions is highlighted in a study of a high-tech aerospace cluster in Taiwan (Eriksson, 2006). Trippl and Tödtling (2007) find that the Austrian biotechnology sector needs local-level and global-level exchanges simultaneously.

In parallel with the approaches mentioned above, I argue that the dichotomy of “local buzz and global pipelines” (Bathelt et al., 2004) should be replaced with a more balanced approach blending both in the basket of knowledge creation. The local buzz–global pipelines approach argues that local interaction or 'buzz’ and interaction through trans-local ‘pipelines’ create a dynamic process of learning, knowledge production, and innovation that is central to understanding a cluster's success (Bathelt, 2007).

Organisations need to interact at different levels. They need enhanced local networks and strong extra-local or global linkages, while paving the way to balance those (Maskell et al., 2006).

2.10. Concluding Remarks and Insights for the Next Steps

Network studies have gained popularity in the academic world. The number of papers about the networks formed under EU Framework Programmes has risen, as well. Breschi and Cusmano (2004), Barber et al., (2006), Roediger-Schulga and Dachs (2006), Cabo (1999), Roediger-Schulga and Barber (2008), and Ortega and Aguillo (2010) are some examples of such studies. Derived from the small-world phenomenon (high clustering and short average relational distances), most studies assume perfect knowledge flow among the partners of a network, which is not the case in reality. Moreover, studies focused on EU programmes are conducted at the supra-national level and leave unaddressed issues related to fluidity of knowledge flows between the local actors of the innovation system – the firms, universities and research

institutions, and the people at national level.EU level studies are extensively focused on the core of networks while little effort is made to understand the impact of EU networks on periphery.

Contemporary studies on FP networks generally focus on a partnership structure as a whole rather than investigating the future performance of different nodes in research networks. In contrary to well-known approaches, looking from the perspective of less-connected nodes of a network could lead to alternative findings which may challenge the contemporary understanding. Such kind of focus may provide an opportunity to expose the nonlinearity of knowledge flows from international collaboration and also local deployment dynamics of collaborative research at international level.

Further investigation is required about the outcomes of international collaboration on local research capacity upgrading. The literature highlights that strengthening the local research capacity of developing countries relies on knowledge networks that are connected both locally and globally (Lall, 2001; Marin and Bell, 2006; Narula and Duning, 2000; Barnard et al., 2012). Starting from 2003, thanks to the gained access for participation in FP networks and increased support of TÜBİTAK for international collaboration projects, many researchers were engaged more extensively in global research activities, but the outcomes of the initiatives remains to be analysed. Going beyond the boundaries of the project networks involved, it is required to study how researchers manage global versus local trade-off and potential heterogeneities at the research level in creating scientific outputs. These concepts can be handled within the context of the local buzz–global pipelines framework, which emphasises both the need for enhanced local networks and strong extra-local or global linkages while paving the way to balance them all (Maskell et al., 2006). The approach argues that local interaction or ‘buzz’ and interaction through trans-local ‘pipelines’ create a dynamic process of learning, knowledge production, and innovation that is central to understand a cluster’s success (Bathelt, 2007).

In order to unlock the gains from international research collaboration and their relation to future outputs of researchers, there is a need to reveal the main drivers of having a strong project portfolio at both national and international levels. Such study cannot be built on quantitative analysis only; it requires in-depth analysis, as well. In order to develop recommendations for future policies, in-depth interviews and focus group meetings are essential to assist in exploiting the open issues to create synergy between global pipelines and local buzz for the benefit of a national innovation ecosystem.

CHAPTER III

TURKEY'S STANDING IN COLLABORATIVE ICT PROJECTS

3.1. Key S&T Indicators for OECD, EU27, EU15, EU12, and BRICS Countries and Turkey

Leveraging R&D as a means of the vision for transitioning to a more innovative, value-added economy is one of the challenges for Turkey in the coming next 10 years. Turkey is now ranked as the 17th economy in the world, whereas it ranked 28th 10 years ago. By the year 2023, Turkey's target is to be in the top 10 economies in the world. This part of the study aims to provide multi-dimensional analysis of Turkey's standing in R&D and ICT research, starting from macro-analysis and finishing with a more micro-scale focus on FP6 and FP7 performance in ICT. Therefore, this section starts with a focus on recent standing with respect to key S&T indicators for the OECD, EU27, EU15, EU12, and BRICS countries and Turkey. "S&T indicators are crucial for monitoring scientific and technological development, and normally used to monitor global technological trends, conduct foresight exercises, and determine specific areas of investment"[14].

Comparative analysis of the recent standing of Turkey in R&D at a global scale will provide a picture useful for formulating, adjusting, and implementing S&T policies. The mapping study is based on main S&T indicators covering R&D expenditures, number of FTE researchers, number of scientific publications, and number of PCT patent filings[15]. Noting that this

[14]http://www.aiwsi.org/sti-indicators.php, accessed on 24 August 2013.
[15]Source: TurkStat, OECD MSTI 2013/I, UNESCO, Thomson Reuters InCites Database, WIPO. Note 1: EU27 includes EU27 plus Croatia for R&D Expenditures, Higher Education R&D Expenditures, and FTE Researchers. Note 2: The reference years are 2009 for South Africa (GERD, HERD, FTE

thesis is mainly focused at the university level, comparisons for higher education R&D are covered as well.

The comparative analysis is done in three parts. To compare the two time intervals covered by the thesis, I looked at the developments for two periods of 2003–2007 and 2007–2011, and then the whole period (2003-2011) were analysed separately as well. The most recent data provided by TURKSTAT and EUROSTAT is available for the year 2011, and so the analysis in this part does not cover the years 2012 and 2013.

Here the momentum in the key S&T indicators was compared for four groups of countries and Turkey, as well as their relative standing when the level of Turkey is taken as 1. In other words, momentum is tagged with percentage change between the first year and last year values for each period, and similarly, in the second analysis, I use fold-change as a measure for describing the value for each group of countries while the value for Turkey as a reference base is equal to 1. In fold-change analysis, three reference years, which are 2003, 2007, and 2011 were used.

Turkey drastically increased the governmental funding for R&D between 2003 and 2011, such that it jumped from 1.3 to 2.6 (2007) and to 3.5 billion TRY (2011), with 101% and 35% growth rates, respectively[16]. This is reflected also in total expenditures of R&D between 2003 and 2011, with a total 291% increase. However, the rate of increase has declined to one-third of that of the previous period during 2007–2011. For example, the momentum of R&D expenditures is behind that of the BRICS countries for 2007–2011. Although in R&D expenditures Turkey has reached the level of

Researchers), 2007 for OECD (FTE Researchers), and 2010 for EU (FTE Researchers). Note 3: Higher Education R&D Expenditures for Brazil not available.

[16] Source: TurkStat; constant prices (2012=1).

EU12[17] countries, it still has a 27-fold difference from the BRICS countries (Table 2)[18].

Table 2: Comparisons for OECD, EU27, EU15, EU12, BRICS, and Turkey regarding total R&D expenditures (Source: TurkStat, OECD MSTI 2013/I, UNESCO)

Total R&D Exp.	Momentum (%)			Standing (taking TR as a reference base, TR=1)		
	2003–2007	2007–2011	2003–2011	2003	2007	2011
OECD	33	13	50	243	130	93
EU27	29	18	52	74	38	29
EU15	27	17	49	71	36	27
EU12	55	45	125	**3.27**	**2.05**	**1.88**
BRICS	89	67	215	33	25	27
TR	148	57	291	-	-	-

This thesis focuses on the research activities of the academic world, and higher education R&D expenditure data are an important area of focus. In line with analysis on total R&D expenditures, similar observations are seen for higher education R&D expenditures, as well. From 2003 to 2011 Turkey reached the same level as EU12 countries, but its momentum is behind that of BRICS countries with a diminishing growth rate (Table 3)[19].

[17] Bulgaria, Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, and Slovenia.

[18] Source: TurkStat, OECD MSTI 2013/I, UNESCO, EU27 includes EU27 plus Croatia for R&D Expenditures.

[19] Source: TurkStat, OECD MSTI 2013/I, UNESCO, Note 1: EU27 includes EU27 plus Croatia for Higher Education R&D Expenditures and FTE Researchers. Note 2: The reference year is 2009 for South Africa (GERD, HERD, FTE Researchers). Note 3: Higher Education R&D Expenditures for Brazil not available.

Table 3: Comparisons for OECD, EU27, EU15, EU12, BRICS, and Turkey regarding higher education R&D expenditures (Source: TurkStat, OECD MSTI 2013/I, UNESCO)

HE R&D Exp.	Momentum (%)			Standing (taking TR as a reference base, TR=1)		
	2003–2007	2007–2011	2003–2011	2003	2007	2011
OECD	28	23	58	65	46	38.4
EU27	28	26	60	25	18	15
EU15	26	24	56	24	17	14
EU12	65	53	153	**1.20**	**1.10**	**1.13**
BRICS	71	78	203	3.8	3.6	4.3
TR	80	49	168	-	-	-

Concerning the FTE researchers' data, Turkey has the best momentum in comparison to the reference group of countries. It should be also noted that although higher education R&D expenditures are at the same level for Turkey and the EU12, the number of FTE researchers in EU12 countries is 2.7-fold greater than in Turkey (Table 4).

Table 4: Comparisons for OECD, EU27, EU15, EU12, BRICS, and Turkey regarding the number of FTE researchers (Source: TurkStat, OECD MSTI 2013/I, UNESCO)

FTE Researchers	Momentum (%)			Standing (taking TR as a reference base, TR=1)		
	2003–2007	2007–2011	2003–2011	2003	2007	2011
OECD	10	0	10	117	85	58
EU27	16	9	27	38	29	22
EU15	16	10	27	34	26	19
EU12	17	8	27	**4.68**	**3.60**	**2.69**
BRICS	39	-5	32	48	44	29
TR	52	45	121	-	-	-

The next two comparisons are more or less of output indicators, while the previous three were of inputs of an S&T system. The findings about the analysis of scientific publications are a mix of previous comparisons of key indicators. Again, Turkey has progressed in that field with a reduced momentum in the second half of the analysis, whereby, in total, the country lies behind the BRICS countries in terms of momentum in scientific publications between 2003 and 2011. On the other hand, fold-change

analysis indicates that EU12 countries are 2.5 times more productive in terms of scientific publications although the higher education expenditures on R&D are almost same. However, Turkey has an increasing momentum in the second half of the analysis as compared to EU12 countries (Table 5).

Table 5: Comparisons for OECD, EU27, EU15, EU12, BRICS, and Turkey regarding the number of scientific publications (Source: Thomson Reuters InCites Database)

Scientific Publications	Momentum (%)			Standing (taking TR as a reference base, TR=1)		
	2003–2007	2007–2011	2003–2011	2003	2007	2011
OECD	9	23	34	83	61	51
EU27	11	27	41	36	26	23
EU15	10	25	38	33	24	21
EU12	15	50	73	**3.08**	**2.38**	**2.46**
BRICS	53	61	146	10	10	11
TR	49	45	116	-	-	-

PCT patent data analysis indicates that BRICS countries and Turkey are the fastest runners to close the gap from the advanced economies. The momentum of BRICS countries is better than that of Turkey while Turkey has reached the level of the EU12 countries, although Turkey's momentum has been reduced between 2007 and 2011 (Table 6,).

Table 6: Comparisons for OECD, EU27, EU15, EU12, BRICS and Turkey regarding the number of PCT patent filings (Source: WIPO)

PCT Patent Filings	Momentum (%)			Standing (taking TR as a reference base, TR=1)		
	2003–2007	2007–2011	2003–2011	2003	2007	2011
OECD	36	7	45	987	417	298
EU27	22	2	25	359	137	93
EU15	22	2	24	354	135	91
EU12	31	20	57	**5.02**	**2.04**	**1.64**
BRICS	145	150	511	29	22	36
TR	221	50	381	-	-	-

This section was focused on comparative analysis between four groups of countries and Turkey. Two main messages can be drawn from the analysis covering the period of 2003–2011, as:

- Turkey has progressed remarkably in terms of the momentum of input- and output-based key S&T indicators, with a relatively falling growth rate in the last part (2007–2011) of the analysis.

- EU15[20] and BRICS[21] countries are still located far ahead of Turkey in terms of all covered indicators, which means that the momentum is not great enough for Turkey to catch up. On the other hand, Turkey is rapidly reaching the level of EU12 countries, except for numbers of FTE researchers and scientific publications.

3.2. Analysis of R&D Funds for ICT Academic Research in Turkey

The R&D funding data for the higher education sector in Turkey highlight a drastic increase on supply and demand side, or, in other words, on government and university side. Although higher education's portion of total R&D expenditure for the performing side dropped from 66.3% to 45.5% between 2003 and 2011, the real values increased from 2.4 to 5.4 billion[22] TRY, respectively. Similarly, the R&D funding of TÜBİTAK dedicated for academic research and also demand for that funding increased 15-fold and 5.6-fold for 2012, respectively (Figures 2 and 3)[23]. If we divide the data into two periods (i.e. 2003–2006 and 2007–2017), we see that from the first to the second period the number of applications increased by 2.8-fold while funding increased by 3.3-fold.

[20]Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, and the United Kingdom.

[21]Brazil, Russia, India, China, and South Africa
[22]Constant prices (2012=1).
[23]Source: TÜBİTAK.

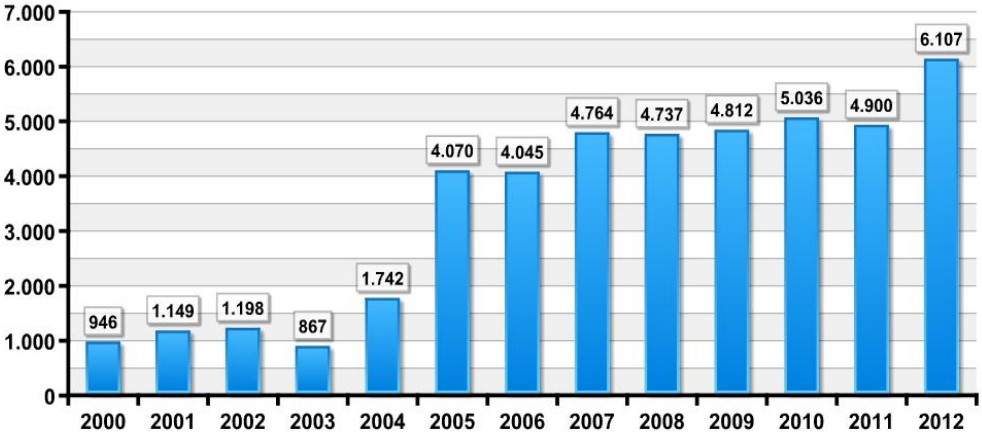


Figure 2: Number of project proposals submitted to TÜBİTAK ARDEB between 2000 and 2012 (Source: TÜBİTAK)

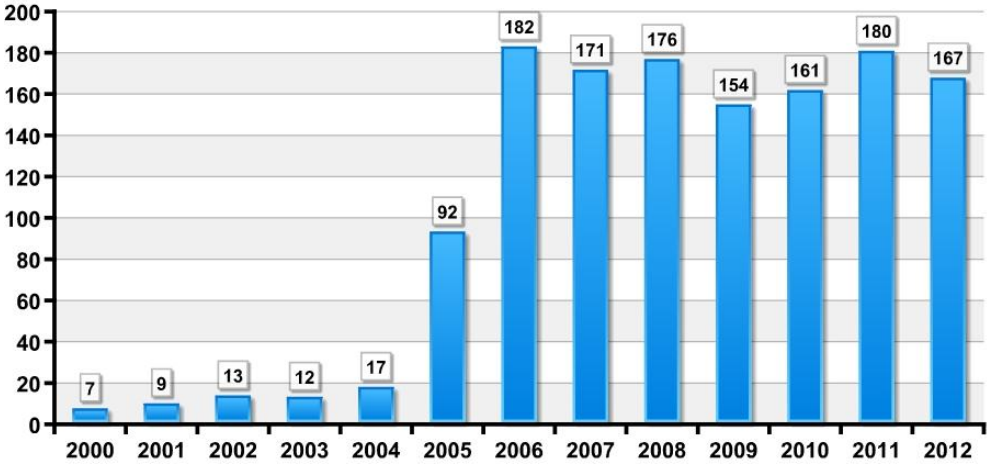


Figure 3: Funds allocated to TÜBİTAK ARDEB projects between 2000 and 2012 (Source: TÜBİTAK, million TRY with 2012 constant prices)

These motivations for R&D in universities are reflected in ICT research data, as well. The number of funded academic projects from the Electrical, Electronics, and Informatics Research Support Group of ARDEB[24] jumped 2.6-fold from the first (2003–2006) to the second (2007–2013) period of this analysis while the actual data jumped from 410 to 1073 (Table 7). Almost 48% of all funded ICT projects belong to six and 60% to 10 universities in Turkey, which means that ICT research capability is clustered among a limited number of universities, especially in Ankara, İstanbul, and İzmir.

[24] Academic Research Support Programs.

Table 7: ICT project performance of Turkish universities based on funded R&D projects by ARDEB (Source: TÜBİTAK)

	University	2003–2013	2003–2006	2007–2013	Cumulative %
	Total	1483	410	1073	
1	METU	158	55	103	
2	BİLKENT	155	55	100	
3	BOĞAZİÇİ	128	34	94	
4	SABANCI	105	43	62	
5	İTÜ	98	25	73	
6	KOÇ	74	26	48	48%
7	KOCAELİ	51	9	42	
8	YTÜ	45	9	36	
9	DOKUZ EYLÜL	44	22	22	
10	HACETTEPE	43	17	26	61%
11	FIRAT	32	2	30	
12	ANADOLU	27	6	21	
13	TOBB ETÜ	26	5	21	
14	İYTE	24	10	14	
15	YEDİTEPE	24	8	16	
16	GEBZE YTE	23	3	20	
17	EGE	23	6	17	
18	S. DEMİREL	22	2	20	
19	IŞIK	19	6	13	
20	ERCİYES	18	2	16	
21	PAMUKKALE	18	3	15	
22	ÖZYEĞİN	16	3	13	79%

3.3. Comparative Analysis of University-Based International Collaboration ICT with Respect to National Research Funding

Following its full association with the EU Framework Programmes in 2003, Turkey attained progress in harmonising its S&T policies with the European Community. Project-based funding for bilateral and multilateral relations increased from 1.4 (2003) to 7,3 (2007) and to 27,1 million TRY (2012), with 476% and 272% growth rates, respectively[25]. Moreover, while the ratio of

[25]Source: TÜBİTAK, Constant prices (2012=1).

bilateral and multilateral funding to total academic funding at TÜBİTAK initially dropped from 0,12 (2003) to 0,04 (2007), recently it has reached 0,16 (2012), which the highest ratio in last 10 years (Table 8). At TÜBİTAK, bilateral and multilateral funding is provided to collaboration projects with other countries or under the COST and EMBO/EMBL programs, so this does not cover the data for FP6 and FP7.

Table 8: Ratio of bilateral and multilateral funding to total academic funding at TÜBİTAK (Source: TÜBİTAK)

Year	Bilat./Multilateral Funding	Total Academic Funding	Ratio
2003	1	12	0,12
2007	7	171	0,04
2012	27	167	0,16

Similar analysis for ICT projects indicates that, although the ratio of bilateral and multilateral projects versus total ARDEB funding increased in the last 10 years, this is not the case for international ICT projects. The same ratio dropped from 0,23 to 0,19 in the case of ICT (Table 9). Here it is supposed that the number of projects and the funding allocated to these projects are correlated strongly, because almost all international projects have similar budgets of up to 360.000 TRY.

Table 9: Ratio of international projects in total funded academic projects in ICT in terms of number of funded projects (22 universities, Source: TÜBİTAK)

	University	2003–2006	2007–2013	2003–2013
	Total	0,23	0,17	0,19
1	METU	0,40	0,19	0,27
2	BİLKENT	0,36	0,35	0,35
3	BOĞAZİÇİ	0,21	0,23	0,23
4	SABANCI	0,28	0,21	0,24
5	İTÜ	0,04	0,18	0,14
6	KOÇ	0,23	0,40	0,34
7	KOCAELİ	0,00	0,12	0,10
8	YTÜ	0,00	0,17	0,13
9	DOKUZ EYLÜL	0,05	0,18	0,11
10	HACETTEPE	0,18	0,15	0,16
11	FIRAT	0,50	0,00	0,03
12	ANADOLU	0,33	0,24	0,26
13	TOBB ETÜ	0,20	0,05	0,08
14	IYTE	0,10	0,29	0,21
15	YEDİTEPE	0,13	0,19	0,17
16	GEBZE YTE	0,00	0,10	0,09
17	EGE	0,33	0,12	0,17
18	SÜLEYMAN DEMİREL	0,00	0,00	0,00
19	IŞIK	0,33	0,08	0,16
20	ERCİYES	0,00	0,06	0,06
21	PAMUKKALE	0,00	0,00	0,00
22	ÖZYEĞİN	1,00	0,38	0,50

Although the overall ratio of the share of international projects in ICT is declining, the six best performing universities were able to sustain their average at around 0,25.

Some other implications from the institutional level analysis of ICT collaborations are listed below:

- In the last 10 years, only 33 universities have set up project-based collaboration at the international level.

- Only six universities have more than 10 project-based collaborations (and it is also seen in Figure 4 that METU, Bilkent, Boğaziçi, Koç, Sabancı, and İTÜ are performing better than other universities).

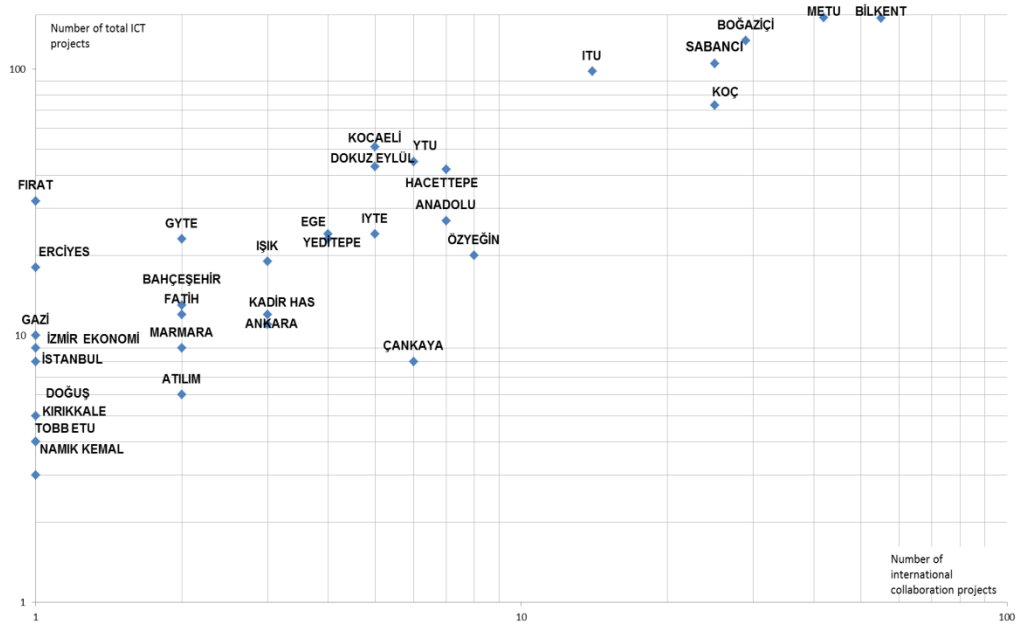


Figure 4: Distribution of ICT projects at university level (total projects vs. international projects at log scale, Source: TÜBİTAK)

- Almost half of the remaining universities have had less than four collaborations in 10 years. Moreover, only six[26] out of 33 universities managed to attain a ratio of international collaboration versus total projects above the mean value, which is 0.22 (blue-filled cells in Table 10)[27]. This means that well-known universities like İTÜ, YTÜ, Kocaeli, Dokuz Eylül, Hacettepe, İYTE[28], Ege, and GYTE tend to be locally oriented universities in ICT research (orange-filled cells in Table 10).

[26]METU, Bilkent, Boğaziçi, Sabancı, Koç, and Anadolu University.
[27]I exclude universities with less than 20 projects. In other words, this study could not take into account universities performing fewer than 2 ICT projects per year.
[28]İYTE's score is just below the mean, indicating that the university could shift itself to the well-perfoming university level.

Table 10: Ratio of FP and bilateral projects to total academics projects in terms of number of funded projects (ICT, 33 universities, Source: TÜBİTAK)

	University	Total projects	International Projects	Ratio
1	METU	156	42	0.27
2	BİLKENT	155	55	0.35
3	BOĞAZİÇİ	128	29	0.23
4	SABANCI	105	25	0.24
5	İTÜ	98	14	0.14
6	KOÇ	73	25	0.34
7	KOCAELİ	51	5	0.10
8	YTÜ	45	6	0.13
9	DOKUZ EYLÜL	43	5	0.12
10	HACETTEPE	42	7	0.17
11	FIRAT	32	1	0.03
12	ANADOLU	27	7	0.26
13	İYTE	24	5	0.21
14	YEDİTEPE	24	4	0.17
15	EGE	23	4	0.17
16	GYTE	23	2	0.09
17	ÖZYEĞİN	20	8	0.40
18	IŞIK	19	3	0.16
19	ERCİYES	18	1	0.06
20	BAHÇEŞEHİR	13	2	0.15
21	KADİR HAS	12	3	0.25
22	FATİH	12	2	0.17
23	ANKARA	11	3	0.27
24	GAZİ	10	1	0.10
25	MARMARA	9	2	0.22
26	İSTANBUL	9	1	0.11
27	ÇANKAYA	8	6	0.75
28	İZMİR EKONOMİ	8	1	0.13
29	ATILIM	6	2	0.33
30	DOĞUŞ	5	1	0.20
31	TOBB ETÜ	4	1	0.25
32	KIRIKKALE	4	1	0.25
33	NAMIK KEMAL	3	1	0.33

3.4. Analysis of FP6 and FP7 Data

The overall comparison on FP6 and FP7 states that the total funding received from the EU jumped from 56 to 193 million Euros[29], which means a 245% increase in total funding received from the European Commission. On the other hand, the funding for the ICT theme jumped just from 11,6 to 20,6 million Euros, with a much lower increase (78%) as compared to the general picture.

Table 11: Turkish researchers in FP6, FP7, FP IST, and FP7 ICT (Source: European Commission)

	Partners in Proposals	Funded Partners	Acceptance Rate
FP6	2982	466	16%
FP7	7429	1097	15%
FP6 IST	592	79	13%
FP7 ICT	952	84	9%

The overall success rate regarding the participant numbers in FP6, FP7, FP6 IST, and FP7 ICT is 16%, 15%, 13%, and 9%, which means that there was a decline in acceptance rates of ICT projects from FP6 to FP7 (Table 11).

Similar comparisons were performed between the EU15[30] and EU12[31] countries and Turkey, with addition to momentum and standings of EU15 and EU12 countries as compared to Turkey. Here the momentums of number of partners in funded FP6 or FP7 projects for EU12 and EU15 countries and Turkey, as well as their relative standings, are compared when the level of Turkey is taken as 1. In other words, momentum is tagged with percentage change between FP6 and FP7, and similarly, in the second analysis, I use

[29]Source: European Commission data.
[30]EU15 refers to the 15 old EU member states prior to May 2004 (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, and the United Kingdom).
[31]EU12 refers to the 12 new EU member states as of January 2007 (Bulgaria, Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia, and Slovenia).

fold-change as a measure describing the value for each group of countries while the value for Turkey as a reference base is equal to 1. In fold-change analysis, FP6 and FP7 data are used as two different periods to make the necessary comparisons.

Comparing the findings from Tables 12 and 13, it can be stated that:

- The momentum of Turkey is far higher than that of both the EU15 and EU12 countries, although the acceptance rates are lower than EU15 rates and similar to EU12 rates[32].
- On the other hand, the momentum of Turkey in FP7 ICT is lower than Turkey's general achievements in FP7. Similarly, the acceptance rate is also lower than that of the reference groups of countries as well as the general acceptance rate of Turkey in FP7. Moreover, Turkey's standing in ICT is worse than FP7 in general. This implies that Turkish organisations were relatively less successful in participating in winning consortia, which could be an indicator of the weakness of the ties of Turkish organisations with their European counterparts.
- Weak ties could be explained with the argument of Jeong et al. (2003) that networks show strong tendencies towards preferential attachments within a power law distribution of links dominated by key knowledge hubs. Wagner et al. (2004) and Malerba et al. (2006) state that there are central organisations serve as hubs in Framework Programmes. Taking into consideration the existence of a stable core of interlinked actors since the early FPs with increasing integration over time, it can be argued that it was difficult for Turkish researchers to take part in successful IST projects.

[32] Some other comparisons regarding EU15, EU12, and Turkey are given in Appendix A.

Table 12: Comparison among EU15, EU12, and Turkey regarding FP7 performance (2007–2012, Source: European Commission)

FP7	Number of Funded Partners	Momentum (%)	Standing (taking TR as a reference base, TR=1)	Acceptance Rate
TR	1097	135	1	15%
EU12	9385	24	8.6	16%
EU15	92,379	60	84	20%

Table 13: Comparison among EU15, EU12, and Turkey regarding FP7 ICT performance (2007–2012, Source: European Commission)

FP7 ICT	Number of Funded Partners	Momentum (%)	Standing (taking TR as a reference base, TR=1)	Acceptance Rate
TR	84	6	1	9%
EU12	1086	-15	12.9	11%
EU15	16,360	32	195	17%

Although Turkey has gained R&D funds and know-how via knowledge flows, the Turkish performance in EU IST RTD demonstrates that the country is performing below its potential (Tables 12 and 13). Turkish organisations are still relatively less successful in participating in successful consortia. This can be explained as follows:

There is lack of integration with core networks that have emerged since the early FPs among the key players of the European ICT sector, which can be attributed to the low visibility of Turkish ICT research and weak links with European ICT hubs compared to US institutions.

It can be argued that insufficient Europeanisation of ICT research strategies by Turkish universities is seen, despite the existence of sufficient academic research potential when the outputs of publication data, patenting activity, and interest in European ICT RTD programmes are considered.

While the ERA model emphasises exchange and the formation of networks with corresponding institutions, Turkish researchers have limited their personal contacts with EU researchers. EU IST RTD funded under the FPs is heavily dominated by a small number of hub institutions, including Fraunhofer, CNRS, the Ecole Polytechnique Federale de Lausanne, Philips, Nokia, Siemens, and France Telecom (Wagner et al., 2004; Malerba et al., 2006). These organisations serve to orchestrate research and facilitate the exchange of knowledge among peripheral groups. Hubs dominate both the connectivity between the research organisations from different participant countries, either member states or associated countries, and between different technology areas and research disciplines (Malerba et al., 2006). Therefore, the strength of links with hub organisations directly affects the success of organisations participating in FPs. The present observations on the Turkish ICT sector imply that lack of international networking ability of Turkish organisations with EU ICT hubs has inhibited success in FP6 ICT thematic areas[33]. These observations on the Turkish ICT sector imply that the lack of international networking of Turkish organisations with EU ICT hubs inhibited the achieving of success in thematic areas of FP6 ICT. Recognising that the level of networking of Turkish organisations with EU ICT hubs is not adequate, more effort is needed to link Turkish organisations with EU ICT hubs.

Participation trends of Turkish researchers per IST/ICT objective give insight toward the present Turkish research potential and accumulated experience in ICT. The Turkish ICT sector is mainly application-oriented; 43% of participation[34] in submitted FP6 IST projects was focused on IST applications. Similarly, high interest in e-Government, e-Work, and e-Business[35] in FP6 reflects the focus of the sector. On the other hand, the low success rate (4%) in e-Government, e-Work, and e-Business topics displays

[33] Further linkage and network analysis is needed to unveil the texture of network collaboration dynamics of Turkish institutions. The data given for this study do not allow work on that issue, since project names are anonymous and partners' names in submitted and funded projects cannot be seen.
[34] For 292 out of 687 instances of participation.
[35] Under this objective, 125 participants submitted FP6 projects.

the insufficient involvement of Turkish organisations in EU R&D networks in that field. This also highlights the orientation of ICT solutions market in Turkey toward the US, with the dominance of organisations such as Microsoft, IBM, Cisco Systems, Oracle, and Sun Microsystems.

The success rates in technical fields and applied IST topics in FP6 are slightly different: 12% for technical topics and 7% for applied IST. This difference in success rates could be an indication of more qualified research capability in technical fields, since research in the communications, computing and software technologies, components and micro-systems, and knowledge and interface technology fields is heavily dominated by university researchers.

Both in FP6 and FP7, funded projects are dominated by universities in Ankara and İstanbul. METU, Bilkent University, and Koç University constitute 43% of all Turkish participation in IPs, STREPs, and NoEs when the entire IST/ICT FP experience of Turkey is considered for FP6 and FP7. Involvement of those three institutions increased to 50% in FP7 ICT.

It can be stated that not only do the inter-linkages between the private sector and successful universities in FP6 IST facilitate the participation of private sector actors in FP projects, but they also enable the management and maintenance of previously connected networks with the aid of the experience of the university actors. It can be argued that the most visible Turkish universities in the EU ICT RTD arena can play a pivotal role in transforming the Turkish private sector, and particularly SMEs, in the context of FP7 ICT. Therefore, enhancement of partnerships between successful Turkish universities like METU, Bilkent, Sabancı, and Koç and private sector institutions that perform research activities, and the sustainability of collaborations in previously established networks, could be two options to trigger Turkish private sector involvement in funded projects in FP7.

Encouragement mechanisms for the FP projects that simultaneously involve Turkish private sector actors and universities can be strengthened[36]. This type of support tool can increase the participation level of both university and industry actors from Turkey. Considering that partnership with a successful university in FPs triggers the involvement of the private sector in funded projects, further investigation is needed to fully utilise the existing local collaboration dynamics of ICT players in Turkey.

Since 2004 with the establishment of the National Science and Technology Strategy for the years 2005–2010 (SCST, 2004), Turkey has invested in capacity building and has gradually improved its scientific activities, both in academia and industry. Capacity building is a crucial topic for more enhanced involvement in networks and efficient knowledge diffusion. Wagner (2006) highlights the importance of institutional capacity building:

> "*Local links also increase the likelihood that knowledge creation focuses on issues relevant to the developing countries rather than on issues that concern only scientists in advanced countries. [Therefore] the question for developing countries is not how to get into collaborations with Germany, the UK or the US, but how to take applicable knowledge from the network (no matter where it is located), make it relevant to local needs and problems, and tie it down".*

Although in the early 20th century Turkish higher education was based on a model inspired by Europe (in particular the German model), after WWII it became increasingly common to look towards the American model (Godelier and Gallie, 2005). This was true with respect to the preference of the best Turkish students towards US schools and even, in many universities, to the recruitment of academic staff with US doctorates. In order to benefit more from FPs, there is a need for more European-trained researchers that could build ties for more enhanced collaboration with European organisations.

[36] One of the sources of TÜBİTAK financial support to encourage Turkish researchers from industry, university, and public organisations willing to participate in the EU Framework Programme is called the TÜBİTAK EU FP Support Programme for Multiple Partnerships from Turkey.

Therefore, an enhanced strategy for brain circulation in the field of ICT research with emphasis on Marie Curie Actions[37] among European countries and Turkey will be beneficial for both sides for better integration of the Turkish RTD community into the ERA.

[37] A fellowship programme under FP6 to facilitate mobility of researchers.

CHAPTER IV

METHODOLOGY OF RESEARCH

This study is designed to identify the relationship between global interactions and local engagements of Turkish researchers in ICT. It is built on deployed mixed methods regarding global pipelines and the local buzz phenomenon, aiming to provide evidence from Turkish case. Therefore, at the initial stage, developing and justifying a framework for global–local connectivity is essential to investigate the global–local relationship. Several studies mentioned that research capacity upgrading in developing countries relies on knowledge networks that are connected both globally and locally (Wagner, et al., 2004; Lall, 2001; Marin and Bell, 2006; Narula and Dunning, 2000). In the context of the thesis, creating a balance between global and local connections and sustaining both types of engagements simultaneously is defined as the optimal situation at the researcher level in an innovation system.

In this study, ICT researchers engaged in international collaboration have been handled in four groups in order to analyse similarities and differences with reference to their future performance in terms of national and international project portfolios, involvement in decision making processes on academic project funding, publication outputs, and contributions to private sector capacity upgrading.

Project portfolios of ICT researchers engaged in international collaboration are not same, although they have similar backgrounds. Internationally engaged researchers may choose to deepen their participation into global collaboration or alternatively may expertise on benefiting from national

programmes only. On the other hand, ideally placed researchers are those who are engaged strongly at both levels: globally and locally (Barnard et al., 2012). Moreover, it is expected that some of the researchers will become less active in the ICT field, because of retiring, shifting to another scientific discipline or starting a business. In line with the typology of Graf (2011), four alternative groups are listed in Table 14.

Comparative analysis of these four groups is performed and initiatives of the best-performing universities are also framed with follow-up in-depth interviews. Understanding the strategies and ecosystems of selected universities makes it easier to frame the most ideal conditions for more productive researchers in Turkey with reference to the quantitative part of the study.

Table 14: Taxonomy for assigning the degree of local versus global focus of ICT researchers

Local Buzz	Global Pipelines	Quadrant Terminology	Typology of Graf (2011)	Features
1	**0**	II	Internally oriented	Locally active researcher with lack of international connections
0	**1**	IV	Externally oriented	Strong interactions with global pipelines, but difficulty in engaging locally
0	**0**	III	Inactive	Mostly inactive researchers in terms of local and international project portfolios
1	**1**	I	Gatekeeper	Both locally and globally engaged researcher acting as bridge linking advanced world with national agenda

It should be noted that there is a lack of holistic databases matching international and national project portfolios, publication outputs, and other scientific engagements of researchers in Turkey. Moreover, there are no metrics or frameworks for assessing which type of project (i.e. FP6 projects, career grants, or ARDEB 1001 projects) is more prestigious than others.

Therefore, in this study, focus group assessment was deployed to differentiate the weights of different project types available for Turkish ICT researchers.

In this study, the main subject of analysis is “Turkish ICT researchers” and universities are determined as spaces that provide the necessary ecosystem for researchers to reach the best scientific outputs. The main focal points are different combinations of local and international engagements of researchers and their relation to future project portfolios, scientific publications, and contributions to governance of STI at academic and also private sector levels. The findings help to understand the role of global linkages on local dynamism at researcher level and also at university level. Different combinations of degrees of local and global engagements followed by the tracking of future scientific performances of the four groups provide useful findings to frame characteristics of different groups. Gathered from the findings, possible policy options can be highlighted for successful university-based research in Turkey.

Starting from the initiation phase of the study, several face-to-face discussions were held with people who have deep understandings of current research dynamics in Turkey and well-known, world-class researchers who lead the theoretical and empirical studies of their fields. These people include managers of the funding programmes of TÜBİTAK, former board members of TÜBİTAK, current top managers from TÜBİTAK, vice-rectors of several universities responsible for research management, and well-known researchers like Franco Malerba and Caroline Wagner. Moreover, a special focus group meeting was performed with the Members of the Execution Committee of the Electrical, Electronics, and Informatics Research Support Group at TÜBİTAK.

The study is based on 79 Turkish ICT researchers who were engaged in at least one international project-based collaboration between 2003 and 2006.

Those individual researchers constitute the target population of the study. A target population is the complete collection of objects (for example, researchers) that we want to analyse, where according to Lohr (2010) choice of target population affect the statistics that result from data. However, identifying ICT researchers is not an easy task due to the fact that there is no easy definition of ICT researchers in Turkey. Some people define them as academics from computer engineering departments, while other definitions include those from electric and electronics engineering departments of universities. Another definition also includes the ICT people from the private sector and from public research organisations. In this study, ICT researchers are defined as people who received academic funding from the Electrical, Electronics, and Informatics Research Support Group of TÜBİTAK or participants in funded FP6 IST projects. Therefore, the project data of Turkish ICT researchers over a four-year period from the beginning of 2003 to the end of 2006 were used. Details regarding how this dataset was constructed and manipulated are presented in the following parts.

It is also crucial to define what we understand from "international collaboration". First, it should be noted that in this study we are referring to project-based collaboration that exceeds national boundaries. The international project-based actions are defined here as involvement in funded FP6 projects or international collaboration projects funded by TÜBİTAK. The funded international projects by TÜBİTAK can be bilateral projects among the researchers of two countries or COST projects[38].

In line with the global pipelines–local buzz literature (Bathelt et al., 2004; Maskell et al., 2006; Gertler and Levitte, 2005; Moodysson, 2008; Trippl et

[38] TÜBİTAK has bilateral cooperation agreements with a variety of countries at the intergovernmental or inter-institutional levels. Within the framework of such agreements, common research projects are supported and monitored; financial support is provided for several different types of activities such as common scientific meetings, exchange of scientists, scientific visits, etc. Besides, TÜBİTAK supports participation of Turkish researchers COST (European Cooperation in the field of Scientific and Technical Research) projects (Retrieved from http://www.tubitak.gov.tr/en/about-us/content-international on 30 September 2013).

al., 2009, Grabher and Ibert, 2013), it is expected that the agents who constitute the population will show heterogeneous features, where some researchers have extensive international actions, some are locally focused, and others are balanced in terms of global–local dynamism. This is also in parallel with the literature on social networks, where the agents holding a brokering position between two groups of actors are defined as gatekeepers (Gould and Fernandez, 1989; Graf and Krüger, 2009; Graf, 2011; Foster et al., 2011). In our expectations, these two groups are internal- and external-oriented actors, respectively (Graf, 2011). Moreover, we expect that some agents will perform below average in terms of number of projects handled by researchers involved in international collaboration or those who are active at the national level, respectively. Based on such division it is argued that researchers belonging to different groups have different scientific outputs or performances in a given time interval.

As derived from the examples in the literature (Graf, 2011; Dubois et al., 2012; Akçomak et al., 2013), researchers can be divided into four sub-groups in terms of their degrees of diversity in global and local orientation. The taxonomy is formed from the four sub-groups, or it can be said that a 2×2 matrix is considered where every researcher in the population is associated to one of the groups.

A special dataset is constructed as result of matching five different datasets from three different institutional sources at the researcher and university levels for the years 2003–2013:

- Publication data obtained from ULAKBİM,
- Academic project portfolio obtained from TÜBİTAK ARDEB,
- Reviewers' datasets obtained from TÜBİTAK TEYDEB and TÜBİTAK ARDEB,
- PhD and overseas work experience data obtained from ARBİS,

- FP6 and FP7 project portfolios obtained from the European Commission through the National Coordination Office at TÜBİTAK.

Such types of comprehensive datasets provide detailed information and opportunities to make comparisons regarding the scientific outputs of researchers and universities in the ICT field for a certain time interval.

At the project level, there are different mechanisms available for Turkish researchers, whereby some of them are enhancing international collaboration and others are focused on the country level. During the several discussions with area experts and researchers, it was mentioned that different mechanisms have different weights in terms of scientific prestige, time spent, degree of difficulty to obtain funding, etc.

In line with such feedback from people who have in-depth knowledge of research dynamics in Turkey, different mechanisms (e.g., TÜBİTAK 1001, TÜBİTAK 1002, TÜBİTAK 1003, career grants, FP6 and FP7 projects, other international projects) are classified according to their distinctive features, such as success rates of Turkish researchers in the particular programme, their complexity, requirements of the programs, and the position of researchers in the project (i.e. being an investigator or a researcher in a certain project).

For example, a TÜBİTAK 1001 project (“The Support Program for Scientific and Technological Research Projects”) corresponds to 100 unit points, which is assumed as a baseline, while another type of project, a 1002 project (“Short-Term R&D Funding Program”), supports immediate start-up requirements with small budgets and is scored as 25 unit points. Moreover, if a researcher is involved in an FP6 or FP7 project, then s/he receives 150 unit points because of the difficulties of these types of projects relative to national ones. Different roles played in TÜBİTAK-funded projects are also differentiated; for example, if a researcher leads a 1001 project then s/he

gets 100 unit points, whereas s/he gets 50 unit points if s/he is just a contributor (i.e. researcher) in the project team.

Differentiated weightings for different mechanisms are derived from an internal study at TÜBİTAK performed with an expert group to reflect the quantity and quality of outputs of Turkish researchers who have already received funding from national or international mechanisms. Expert group judgements or weighting studies are often utilised in composite S&T indices (Moon and Lee, 2005). Our expert group is composed of two high-level executives of TÜBİTAK at the top management level; area experts from three identical disciplines such health, engineering, and economics; and two technical experts with expertise on different funding mechanisms in the Turkish research system. As it is emphasised by the OECD (2008)[39], expert opinion is one of the techniques to define weights for constructing a composite index. In other words, weighting factors are estimated values indicating the relative importance or impact of each mechanism as compared to the other mechanisms available[40]. The purpose of assigning weighting factors is to establish priorities, and in the performance appraisal, they help to determine an accurate overall performance at individual or institutional levels. They are generally used for reflecting policy priorities or theoretical factors better, while some analysis might be done by using weights based only on statistical methods such as factor analysis or on participatory methods such as analytic hierarchy processes.

The weighting assignment was obtained from a consensus reached after four face-to-face meetings of the expert group and also e-mail discussions held between March and June 2013. A summary showing the weightings is given below (Table 15):

[39]OECD, 2008, Handbook on Constructing Composite Indicators Methodology and User Guide.
[40]http://www.lehigh.edu/~inhro/documents/GPS_WeightingFactors_Handout.pdf.

Table 15: Weighting assignments for TÜBİTAK and EU Commission funding mechanisms available for Turkish researchers (Source: Expert group elaboration)

	Funding Authority	Project Investigator (Weight)	Researcher (Weight)
TÜBİTAK 1001 - Support Program for Scientific and Technological Research Projects	TÜBİTAK	100	50
TÜBİTAK 1002 - Quick Support Program	TÜBİTAK	25	12,5
TÜBİTAK 1003 - R&D Funding Program For Priority Areas	TÜBİTAK	175	87,5
TÜBİTAK 3501 - National Young Investigator (Career) Development Program	TÜBİTAK	80	40
FP6 and FP7 Projects	European Commission	150	150
TÜBİTAK 1011 - Participation Program for International Scientific Research Projects	TÜBİTAK	125	62,5
Bilateral and Multilateral Projects	TÜBİTAK	125	62,5

The objective of this research is to collect more information about the main features of Turkish ICT researchers engaged in international research and investigate whether they create local dynamism at the individual level. Moreover, the study puts special emphasis on Turkish university participation in FP6, or in other words on participants originally funded by the European Commission between 2003 and 2006. Therefore, the taxonomy is framed according to the data of Turkish researchers participating in at least one international ICT project funded by an academic funding department of TÜBİTAK or the European Commission between 2003 and 2006. In other words, the unit of analysis is the project portfolio of a researcher. If a project is funded by the FP6 Information Society Technologies sub-theme or the Electrical, Electronics, and Informatics Research Support Group of TÜBİTAK ARDEB, it is considered to be an ICT project. In line with this, private sector participants from Turkey were disregarded in this framework since they are funded at the firm level. However, the funded projects of researchers from the private sector under the Electrical, Electronics, and Informatics Research

Support Group of TÜBİTAK were not eliminated since they are funded at the researcher level and firms in such projects act as hosting institutions rather than performing bodies.

A study to match TÜBİTAK and European Commission data as based on the conditions explained above provided 79 individual cases from Turkey. These cases constitute the population of Turkish researchers funded either by the European Commission or TÜBİTAK and engaged in international collaboration projects that started between 2003 and 2006. Benefiting from the raw data, we can find the total number of international projects of a researcher, but we cannot accurately judge the degree of international collaboration focus. Therefore, we need to calculate each type of project assigned to a researcher with its corresponding weight from Table 15 for a given weight function $w: A \to \mathbb{R}^+$; the weighted sum is defined as:

$$\sum_{a \in A} f(a)w(a). \quad (1)$$

Here, f(a) is one of the project types listed in Table 15 and w(a) is its corresponding weight. If the researcher is not functioning as a project investigator for the mentioned project, then the weight is reduced by half, except for FP projects.

Weighting allows us to differentiate the values according to each project mechanism that the researcher is engaged in and to increase the distance between the values for degrees of international focus of researchers.

The same approach is applied for the local projects of 79 researchers funded by TÜBİTAK between 2003 and 2006. This helps to set the degrees of local dynamism for each researcher from the population. To conduct such analysis, the track record (2003–2006) of each researcher in TÜBİTAK 1001, TÜBİTAK 1002, and TÜBİTAK 3501 programmes is matched with the previous dataset on international collaboration. A weighted

sum corresponding to a degree of local dynamism is then calculated for each researcher.

After these calculations, achieving two-dimensional degrees of international focus and local dynamism for each researcher offers a significant advantage for mapping researchers' individual preferences or attainments in terms of being local or global.

Following the works of Akçomak et al. (2013) and Graf (2011), obtaining two-dimensional degrees from the matching and weighted sums allows mapping the researchers' positioning. Two-dimensional data can be plotted on a two-dimensional Cartesian system where the data are divided into quadrants as shown in an illustration in Figure 5. In our case based on the mean of the variables the two dimensions are the degrees of international and local engagements, respectively.

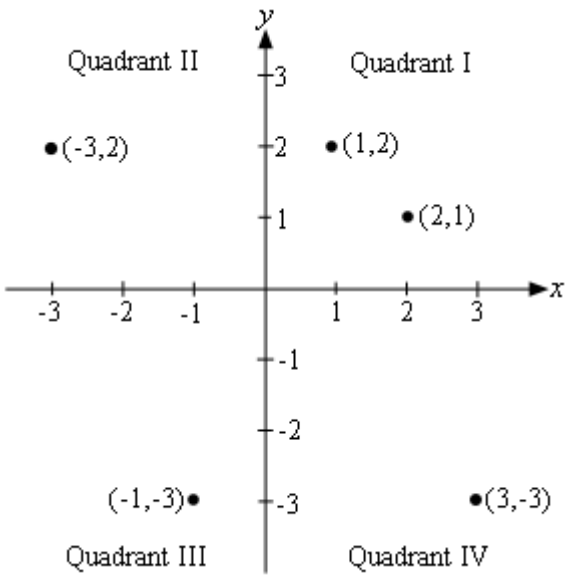


Figure 5: Sample quadrants (Source: Lamar University)[41]

[41] Retrieved from http://tutorial.math.lamar.edu/Classes/Alg/Graphing.aspx on 30 September 2013.

The sample quadrants in Figure 5 are transformed according to typology at Graf (2011) where actors (researchers, in this case) are categorised in terms of their intensity of internal and external relations (Figure 6).

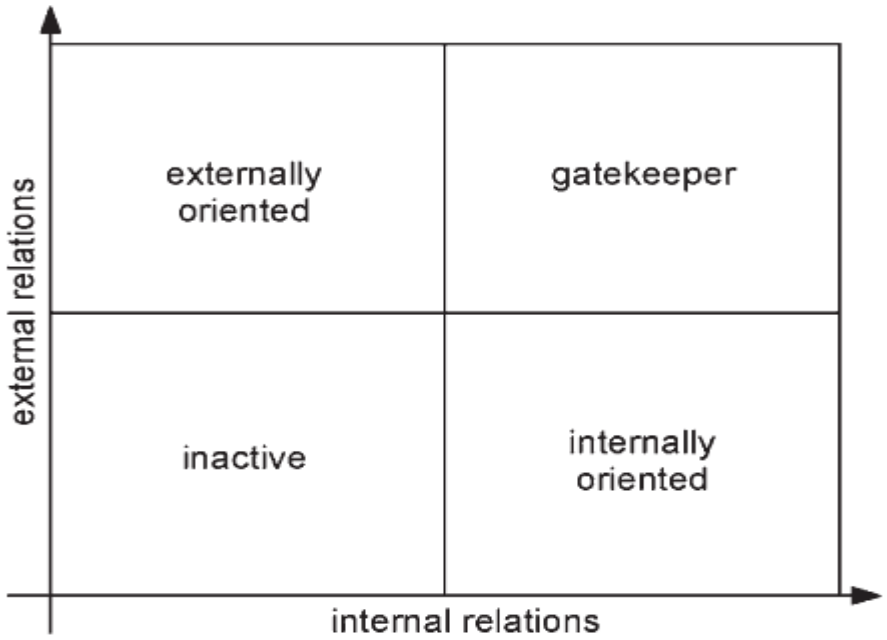


Figure 6: Taxonomy of ICT researchers in Turkey in terms of degrees of external relations and internal relations (adapted from Graf, 2010)

Descriptive statistics related to the distribution of intensity of internal and external relations are provided in Tables 16 and 17, respectively.

Table 16: Descriptive statistics on international project portfolios

Int. Project Portfolio	Quadrant	Frequency	Median	Mean	Std. Dev.	Min.	Max.
Gatekeeper	**I**	18	212.5	265.3	161.6	150	775
Externally oriented	**II**	13	150	189.4	65.3	150	300
Internally oriented	**IV**	17	125	99.3	31.7	62.5	125
Inactive	**III**	31	62.5	84.7	30.4	62.5	125
Total		79	125	146.2	111.0	62.5	775

Table 17: Descriptive statistics on local (national) project portfolios

Local Project Portfolio	Quadrant	Frequency	Median	Mean	Std. Dev.	Min.	Max.
Gatekeeper	**I**	18	100	106.4	58.9	50	300
Externally oriented	**II**	13	0	0	0	0	0
Internally oriented	**IV**	17	100	98.8	39.8	50	200
Inactive	**III**	31	0	0	0	0	0
Total		79	0	45.5	60.6	0	300

According to the applied sampling design based on separating the population into four categories, Quadrant I represents gatekeepers, Quadrant II externally oriented researchers, Quadrant III inactive researchers, and Quadrant IV internally oriented researchers. Below, the features of each category are explained briefly.

Gatekeepers: While they are engaged in international collaboration above the mean value, they simultaneously lead at least one nationwide project.

Externally oriented researchers: They are totally internationally focused for the period between 2003 and 2006. Although they have only international projects, their weights are mostly less than those of gatekeepers, who manage both national and international projects.

Inactive researchers: The bulk of researchers fit into this group. They are mostly contributors to funded projects, rather than being investigators of the projects. Their weights lie below the mean values of both axes.

Internally oriented researchers: They are engaged in international projects, but they are mostly inward looking researchers in the years between 2003 and 2006.

Following the formation of the taxonomy and sampling of the population, global and local performance of the same population was traced for the period of 2007–2013 with respect to:

- each group's international and national project densities separately,
- publication output,
- involvement in decision making processes on academic project funding, and
- contribution to R&D capacity development in the private sector.

In order to select the indicators that can be used to describe the local engagements of ICT researchers who participated in international research projects, a comprehensive list of indicators on the basis of literature of STI indicators (e.g., Freeman and Soete, 2009; Laranja and Boavida, 2012; Becic, 2011) is constructed. During this process, a series of interviews were conducted with the experts to inspect the validity of the overall framework. The list was then thoroughly revised according to the feedback from the focus group meeting and bilateral discussions held with TÜBİTAK managers from the funding side (i.e. the manager of the Electrical, Electronics, and Informatics Research Support Group; an expert with extensive experience with the Social Science Research Support Group at TÜBİTAK; and an expert on composite indicators) and area experts (i.e. academicians from the ICT field and practitioners of innovation policy).

Moreover, the data constraints from the interoperability of databases and time limitations did not allow inclusion of some of the most cited indicators from STI policy literature. For example, it was not possible to use patent data because of a matching problem between the databases of TÜBİTAK and the Turkish Patent Institute. A similar reason prohibited extension of the database with other mechanisms available in Turkey, like SANTEZ, KOSGEB, Development Agencies, and TTGV programs, because it is not possible to match data at an individual level. Additionally, ULAKBİM was not able to provide data on co-authorship dynamics of ICT researchers in Turkey.

Moreover, the TEYDEB database did not allow calculation of the number of consultancies in funded private sector projects as provided by the ICT researchers.

Here, it is argued that different groups have different research outputs in a certain period of time. This argument is tested on the basis of key indicators for the period of 2007–2013. Using the two-sample t-test, differences or similarities among the groups are detected.

Multiple t-tests are carried out to compare the means of these 4 groups separately and to understand which groups were different. There are three different ways to construct the hypothesis for comparing the means of two independent samples through traditional hypothesis testing. These are the one-tailed t-test (right-tailed and left-tailed) and two-tailed t-test. The two-tailed t-test considers the extreme effect in both directions, whereas the one-tailed t-test considers it for only one direction. Here, it is preferred to use the two-tailed t-test instead of the one-tailed t-test so as to not miss the effect in the untested direction and to see the total extreme effect in both directions. Therefore, the null hypothesis that means of two groups are equal versus the alternative assuming that they are different, as given below is tested.

$H_0: \mu_1 = \mu_2$

$H_1: \mu_1 \neq \mu_2$

There are also two different options for the use of t-tests[42]. One of them is used when the variances of the populations are not equal, and the other is used when they are equal. These formulas are given below for both options respectively.

[42] Bluman, A.G., 2001, Elemantary Statistics, A Step by Step Approach, 4th edition.

$$t = \frac{(\overline{X_1} - \overline{X_2}) - (\mu_1 - \mu_2)}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}, degrees\ of\ freedom: smaller\ of\ n_1 - 1\ or\ n_2 - 1 \quad (2)$$

$$t = \frac{(\overline{X_1} - \overline{X_2}) - (\mu_1 - \mu_2)}{\sqrt{\frac{(n_1-1)s_1^2 + (n_2-1)s_2^2}{n_1 + n_2 - 2}}\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}, degrees\ of\ freedom: n_1 + n_2 - 2 \quad (3)$$

If the positive critical t-value for the defined significance level is smaller than the positive t-value calculated with the above formulas or if the negative critical t-value for the defined significance level is greater than the negative t-value calculated with the above formulas, then one can claim that there is enough evidence to reject the null hypothesis (H_0).

To determine which formula is appropriate for use with the t-test, an f-test should be done to check whether the variances are equal or not. In the f-test, the null hypothesis is the equality of the variances of two populations, and the formula is the ratio of two variances with $n_1 - 1$ and $n_2 - 1$ degrees of freedom for the numerator and the denominator, respectively.

After justification of the four groups for positioning the globally and locally based project portfolios of researchers, this study focuses on finding statistically significant answers to the question of why such a grouping is exists. This part holistically covers the period between 2003 and 2013 without dividing it into two time intervals and traces the backgrounds of researchers while examining the similarities and differences in:

- PhD education,
- publication outputs before 2003,
- research ecosystem of university, and
- overseas work experience after PhD fulfilment.

Here again, the two-sample t-test is deployed to check whether there is a relationship between the researcher's current standing and his/her given background information.

The last parts of the study are constructed from the findings of in-depth interviews and focus groups, which assist in setting policy recommendations to exploit the synergy between global pipelines and local buzz for the benefit of a national innovation ecosystem.

CHAPTER V

EMPIRICAL FINDINGS

In this part of the study, the results of the statistical and qualitative analyses are presented. Concerning the statistical part, discussions of the research hypotheses are divided into sections investigating the performance of the four quadrants (i.e. groups) between 2007 and 2013. A special supplementary section is dedicated to manipulating determinants having relationships with the performance of researchers. The last part details the findings of the qualitative study.

5.1 Performance Tracking of the Four Groups in Terms of Key Indicators

As mentioned before, this study elaborates on the involvement of Turkish ICT researchers in FP6 networks and in other TÜBİTAK-funded international collaboration projects with regard to the question of whether global pipelines enhance local buzz. In other words, we are investigating whether there is a significant relationship between international collaboration and local dynamism. In order to reach a conclusion, we need to perform empirical research on the different groups that were established in Chapter IV. Based on taxonomy regarding the degrees of external and internal relations of ICT researchers in Turkey, we need to elaborate on outputs of the different groups. In particular, gatekeepers and externally oriented researchers are the main interest of analysis, because we need to show whether researchers engaged in international collaboration also show interest in nationwide studies and programs. The track records of the other two groups, namely the internally oriented and inactive researchers, will also provide opportunity to make comparisons among the four groups. Therefore, multiple t-tests to separately compare the means of these four groups are performed. Based on

such comparisons, we will be able to understand which groups, if any, are different from the others.

The key indicators utilised for comparisons among gatekeepers, externally oriented researchers, internally oriented researchers, and inactive researchers are:

1. Involvement in decision making processes on academic project funding,
2. Contribution to R&D capacity development in the private sector,
3. National project density,
4. International project density, and
5. Publication output.

The first three indicators are directly related to researchers' activities in the national ecosystem. We will try to find whether there is a significant relationship between international project involvement and local contributions of researchers.

Additional analysis will then be performed to see whether prior roots, background, and ecosystem conditions are related to international and local portfolios of Turkish ICT researchers.

5.2 Involvement in Decision Making Processes on Academic Project Funding

Here we test whether internationally engaged researchers are contributing to national decision-making and monitoring processes regarding academic research projects. This analysis covers the period between 2007 and 2013.

Multiple t-tests are performed to compare the means of these four groups separately and to understand which groups are different. First, an f-test is done to check whether the variances are equal or not. In the f-test, the null hypothesis is the equality of the variances of two populations, and the

formula is the ratio of two variances with $n_1 - 1$ and $n_2 - 1$ degrees of freedom for the numerator and the denominator, respectively (Table 18).

Table 18: Summary of f-test (involvement in decision making processes on academic project funding)

F-test for Variance Comparison	Gatekeepers	Externally Oriented	Internally Oriented	Inactive
Gatekeepers		0.046	0.60	0.00
Externally Oriented			0.12	0.64
Internally Oriented				0.01
Inactive				

We reject the null hypothesis for the following comparisons: gatekeepers and internally oriented researchers, externally oriented researchers and internally oriented researchers, and externally oriented researchers and inactive researchers. Therefore, we use two different formulas to perform the t-test. Table 19 shows which formula is used for which comparison.

Table 19: Alternative formulas for t-test

Formula	**Comparison**
$t = \frac{(X_1 - X_2) - (\mu_1 - \mu_2)}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$, $degrees\ of\ freedom: smaller\ of n_1 - 1\ or\ n_2 - 1$	• Gatekeepers & internally oriented researchers, • Externally oriented researchers & internally oriented researchers, • Externally oriented researchers &

	inactive researchers.
$t = \frac{(\overline{X_1} - \overline{X_2}) - (\mu_1 - \mu_2)}{\sqrt{\frac{(n_1-1)s_1^2+(n_2-1)s_2^2}{n_1+n_2-2}}\sqrt{\frac{1}{n_1}+\frac{1}{n_2}}}, degrees\ of\ freedom: n_1 + n_2 - 2$	• Gatekeepers & externally oriented researchers, • Internally oriented researchers & inactive researchers • Gatekeepers &inactive researchers.

After the f-test, a t-test is performed and we find that, concerning the involvement in the decision-making processes of TÜBİTAK, gatekeepers and internally focused researchers are not different at a 0.05 significance level (Table 20). The performance of externally oriented and inactive researchers is not different at the 0.05 significance level, as well.

Table 20: Summary of t-test (involvement in governance mechanisms)

T-test for Mean Comparison	Gatekeepers	Externally Oriented	Internally Oriented	Inactive	Mean	Std. Dev.
Gatekeepers		0.00	0.38	0.00	8.2	5.4
Externally Oriented			0.00	0.71	1.5	3.0
Internally Oriented				0.00	6.6	4.7
Inactive					1.2	2.7

These findings imply that involvement of gatekeepers and internally focused researchers in the assessment processes of TÜBİTAK are more common than involvement of the other two groups. Those who are not active at the local level, or in other words those who are only active in the international

dimension, did not pay much attention to being an evaluator or reviewer for TÜBİTAK-funded academic projects. In other words, it can be said that researchers only engaged internationally do not present dynamism to participate in national research governance mechanisms. They appear more isolated. This situation should be analysed deeply during interviews.

Researchers active at both local and global levels show high interest in taking part in national governance systems. They bring suggestions, but they also share their problems. At the same time, they are not so much critical of the system.

5.3 Contribution to R&D Capacity Development in the Private Sector

Another indicator tested in tracking the performance of the four groups is researchers' contribution to R&D capacity development programs. Here, in a similar way, we analyse the similarities and differences of the four groups regarding their data on contributing to the capacity enhancement of the Turkish private sector. Initially, an f-test is performed, followed by a t-test, for each pair of groups. Below the results are presented in two tables, where cells filled with darker colour mean that the comparison is not significant at the mentioned significance level (Tables 21 and 22).

Table 21: Summary of f-test (contribution to R&D capacity development in the private sector)

F-test for Variance Comparison	Gatekeepers	Externally Oriented	Internally Oriented	Inactive
Gatekeepers		0.02	0.09	0.10
Externally Oriented			0.00	0.19
Internally Oriented				0.00
Inactive				

Table 22: Summary of t-test (contribution to R&D capacity development in the private sector)

T-test for Mean Comparison	Gatekeepers	Externally Oriented	Internally Oriented	Inactive	Mean	Std. Dev.
Gatekeepers		0.01	0.75	0.00	23.2	19.3
Externally Oriented			0.11	0.76	7.6	9.6
Internally Oriented				0.07	20.5	29.4
Inactive					6.3	13.8

Based on the results, gatekeepers and internally oriented researchers, externally oriented and inactive researchers, and externally oriented and internally oriented researchers are not different at the 0.1 significance level.

These findings say something interesting. More precisely, as a weak correlation but nonetheless important, in my opinion: those who are only active globally surprisingly tend to take part in the processes of TEYDEB (previous analysis stated that this same group of researchers were effective in governance mechanisms of academic programmes at the 5% significance level). This trend is not as strong as that of gatekeepers or internally oriented researchers, but this group is not indifferent to contributing to R&D processes in the industry. It seems wiser to encourage these people to contribute to private sector R&D studies rather than to academic governance processes.

5.4 Density of National Projects

As mentioned in the methodology section, we first need to find the density of national projects of researchers. Therefore, we need to calculate each type of project assigned to a researcher with its corresponding weight from Table 15 from the methodology part of this study. Based on the expert group study, Table 15 lists corresponding weights for each project type under review. As mentioned before, if the researcher is not functioning as a project investigator in the mentioned project, then the weight is reduced by half, except for in the case of FP projects. To conduct such analysis, the track record (2007–2013)

of each researcher in TÜBİTAK 1001, TÜBİTAK 1002, and TÜBİTAK 3501 programmes is matched with relevant groups. A weighted sum corresponding to a degree of local dynamism is then calculated for each researcher. Following the findings of the weighting study, f-tests and t-tests are performed regarding the possible six combinations for the pairs of four groups. The findings are listed in Tables 23 and 24.

Table 23: Summary of f-test (density of national projects)

F-test for Variance Comparison	Gatekeepers	Externally Oriented	Internally Oriented	Inactive
Gatekeepers		0.20	0.64	0.00
Externally Oriented			0.40	0.18
Internally Oriented				0.01
Inactive				

Table 24: Summary of t-test (density of national projects)

T-test for Mean Comparison	Gatekeepers	Externally Oriented	Internally Oriented	Inactive	Mean	Std. Dev.
Gatekeepers		0.09	0.55	0.01	84.6	86.7
Externally Oriented			0.22	0.28	35.0	60.3
Internally Oriented				0.02	67.6	76.9
Inactive					17.1	44.7

There is enough evidence to reject the null hypothesis for the means of gatekeepers and externally oriented researchers at the 0.10 significance level, and also for gatekeepers and inactive researchers, and for internally oriented researchers and inactive researchers, at the 0.05 significance level.

We have enough evidence to claim that gatekeepers and internally oriented researchers perform better on a project basis at the national level. Those who are active both globally and locally are in this category, as well. Externally oriented researchers and inactive researchers in this category do not having significant visibility in national projects between 2007 and 2013.

5.5 Density of International Projects

Following similar steps done for comparing the densities of national projects, the population's raw data on international project performance covering the period between 2007 and 2013 are initially weighted based on project type and roles played in the projects. After obtaining the weighted scores, f-tests and t-test are performed to compare the means of four groups with respect to their international project performance (Tables 25 and 26).

Table 25: Summary of f-test (density of international projects)

F-test for Variance Comparison	Gatekeepers	Externally Oriented	Internally Oriented	Inactive
Gatekeepers		0.96	0.30	0.00
Externally Oriented			0.31	0.00
Internally Oriented				0.08
Inactive				

Table 26: Summary of t-test (density of international projects)

T-test for Mean Comparison	Gatekeepers	Externally Oriented	Internally Oriented	Inactive	Mean	Std. Dev.
Gatekeepers		0,81	0,32	0,01	52,8	65,1
Externally Oriented			0,51	0,06	47,1	65,4
Internally Oriented				0,09	33,1	50,0
Inactive					8,9	34,5

International project performance analysis reveals a striking result. Surprisingly, researchers active only on the local basis between 2003 and 2006 increased their international project performance between 2007 and 2013. We cannot reject the null hypothesis for the mean comparisons in three cases: gatekeepers and externally oriented researchers, gatekeepers and internally oriented researchers, and externally oriented researchers and internally oriented researchers.

Naturally, gatekeepers and externally oriented researchers are leading in this category again. As a result, gatekeepers continue to be the leading side in carrying out projects targeting the both dimensions.

5.6 **Publication Output**

In this section, the four groups are compared with respect to their publication outputs between 2007 and 2013. After performing f-tests and t-tests, the results shown in Tables 27 and 28 are obtained.

Table 27: Summary of f-test (publication output)

F-test for Variance Comparison	Gatekeepers	Externally Oriented	Internally Oriented	Inactive
Gatekeepers		0,00	0,00	0,00
Externally Oriented			0,30	0,12
Internally Oriented				0,69
Inactive				

Table 28: Summary of t-test (publication output)

T-test for Mean Comparison	Gatekeepers	Externally Oriented	Internally Oriented	Inactive	Mean	Std, Dev,
Gatekeepers		0,07	0,09	0,02	43,4	49,0
Externally Oriented			0,85	0,26	18,5	17,4
Internally Oriented				0,12	19,6	13,1
Inactive					12,5	12,4

Mean comparisons of publication data present an interesting situation. Researchers interacting both globally and locally are publishing more than the other three groups. This leads us to argue that the high number of interactions can create linkages to access to more knowledge. The other three groups do not differ significantly among themselves in scientific publishing performance: statistically, externally oriented, internally oriented, and inactive researchers are not different at the 5% significance level.

5.7 Factors Related to Strong Project Portfolio at Both Levels

This section of study aims to explore individual and organisational level factors with influence on having a strong project portfolio at both national and international levels. To this end, four analyses are conducted with the dataset available. The first is about whether holding a PhD degree from a university that is listed among the top 400 universities in the Times Higher Education World University Ranking makes a difference in the project performance of ICT researchers. The second includes bibliometric data authored by ICT scientists from the study population published before 2003; in other words, it covers the publication outputs published in the period before this study had begun. The third is related to holding a position at one of the best-performing Turkish universities. It is supposed that being a member of an advanced research ecosystem will enhance the project outputs of ICT researchers. The fourth is about the overseas work experience of the researchers after the fulfilment of a PhD. These analyses are focused on investing the project portfolio of researchers with each factor mentioned above. Therefore, once again, multiple t-tests are performed to compare the means of the four groups (gatekeepers, externally oriented researchers, internally oriented researchers, and inactive researchers) for each of the four factors.

At this stage, a review was performed of the backgrounds of the researchers that make up the population of the study.

Here, it was examined whether there was a significant relationship between the quality of the PhD degree of a researcher and his or her project performance. The level of the quality of the university where researchers got their PhD degrees is obtained by combining the values of two indexes, namely the Times Higher Education World University Ranking and the academic parts of the Entrepreneurial and Innovative University Index in Turkey.

5.7.1 Quality of PhD Education

The combination of the aforementioned two indexes is the outcome of the expert group that carried out the work of assessing weights for the TÜBİTAK funding programmes listed in the section on methodology. In that study, the expert group assigned scores to graduate and undergraduate programmes of universities. In order to calculate the quality scores for undergraduate, graduate, and PhD programmes of a university, the positioning of that university in the Times Higher Education World University Ranking or the academic parts of the Entrepreneurial and Innovative University Index was taken into account. This methodology is explained below in a more detailed way:

- First, the Times Higher Education World University Rankings for 2012–2013 (THE 400) were taken into account with their original scoring scheme.
- The Turkish universities in the Entrepreneurial and Innovative University Index were then scored by using normalised points received for the “scientific and technological research competence” dimension in 2013.
- The five universities (METU, Bilkent University, İTÜ, Koç University, and Boğaziçi University) that are listed in both indexes got the same scores as in their ratings in the THE 400 rankings. The other Turkish universities in the Index were scored like the first five universities, since the scores for the five universities on both lists were approximately same. The expert group thought that this approach was accurate since the five universities had similar scores on both indexes.
- To reflect education quality more precisely, scores of graduate degree programmes and doctoral education of universities in Turkey were calculated by multiplying undergraduate education scores by 0.8 and 0.6, respectively. These coefficients were derived from discussions of the expert group in which the members agreed that the quality of PhD

education in Turkey is not at the level of undergraduate programmes in Turkey.

Such scoring assigns a quantitative value to each researcher in our population, except for those who fulfilled PhD educations at an overseas university not listed in the Times Higher Education World University Ranking. The values reflect the quality level of the university from which a researcher graduated. Using the values assigned to the researchers, we perform a comparison test to see whether there is a statistically significant relationship between the quality of PhD education and the degree of a researcher's project portfolio. We follow the same steps that we followed in the previous section: first, we perform f-tests for each pair, and then according to the results among the two possible alternatives, we decide which formula will be used for the t-tests. Based on the findings of each, we conduct t-tests for each pair to investigate similarities and differences at the group level. The results are presented in Tables 29 and 30.

Table 29: Summary of f-test (quality of PhD education)

F-test for Variance Comparison	Gatekeepers	Externally Oriented	Internally Oriented	Inactive
Gatekeepers		0,90	0,60	0,16
Externally Oriented			0,58	0,37
Internally Oriented				0,05
Inactive				

Table 30: Summary of t-test (quality of PhD education)

T-test for Mean Comparison	Gatekeepers	Externally Oriented	Internally Oriented	Inactive	Mean	Std, Dev,
Gatekeepers		0,94	0,15	0,03	71,0	24,8
Externally Oriented			0,20	0,11	70,2	25,2
Internally Oriented				0,00	83,2	21,6
Inactive					48,1	35,1

In order to have a considerable project portfolio at both national and international levels, it might be envisaged that the quality of the university from which the doctoral degree was received should above average. The findings show that the researcher profiles in the first three groups do not differ in terms of the quality of the university at which the PhD education was fulfilled. While the means for gatekeepers, externally oriented researchers, and internally oriented researchers are close to each other, the education background of inactive researchers is not as good as that of the other three groups.

We found that in the first three groups', the doctoral education roots of the researchers showed similarities. However, it is not possible to reveal the sources of differences in their performance quantitatively. We need to conduct qualitative interviews in order to find evidences for such differences.

79% of the researchers from the first three groups completed their PhDs in Turkey or abroad at a university listed in the Times Higher Education World University Ranking. Therefore, doctoral education cannot be presented as a distinguishing feature for researchers in those groups.

5.7.2 Publications Before 2003

When examining why there such a grouping exists in terms of performances, the publishing data of the researchers were also analysed. The publication analysis was conducted for the years prior to the period of 2003–2013 and a similar study was performed to see whether there was a relationship between construction of the four groups with respect to the project performance of the researchers and the prior publication performance of the same researchers. After conducting the f-tests and t-tests for six possible pairs of groups, it was revealed that past publication performance does not seem to be related to the project performance as the results were not statistically significant. This means that there are other reasons behind the differences in the 10 years of project performing capacity of the ICT researchers (Tables 31 and 32).

Table 31: Summary of f-test (publications before 2003)

F-test for Variance Comparison	Gatekeepers	Externally Oriented	Internally Oriented	Inactive
Gatekeepers		0,86	0,99	0,16
Externally Oriented			0,86	0,29
Internally Oriented				0,17
Inactive				

Table 32: Summary of t-test (publications before 2003)

T-test for Mean Comparison	Gatekeepers	Externally Oriented	Internally Oriented	Inactive	Mean	Std, Dev,
Gatekeepers		0,68	0,52	0,06	19,1	18,1
Externally Oriented			0,87	0,19	16,0	16,8
Internally Oriented				0,26	14,7	18,1
Inactive					8,0	12,2

5.7.3 Holding a Position at One of the Best-Performing Turkish Universities

According to the findings of the descriptive analysis, 69% of the international projects in ICT were executed by six universities: METU, Bilkent University, Boğaziçi University, İTÜ, Koç University, and Sabancı University. Therefore, we test whether holding a position at one of these six universities makes a statistically significant difference in the project portfolios of the four groups. We set “Holding a Position at One of the Best-Performing Six Universities” as a binary variable.

When we have binary variable, we cannot carry out t-test, but chi-square test by using contingency tables. Chi-square test shows whether there exists relationship between two groups, in other words chi-square test is used to

test the null hypothesis that there is a statistical association between two categories (Corder and Foreman, 2009).

Tables 33 and 34 present the observed and expected data for being recruited in one of best performing six universities respectively. Based on the data listed in the two tables, it was found that there is an association between our groups and holding a position at one of 6 best performing Turkish universities (p=0.00).

Table 33: Observed data for being recruited in one of best performing six universities

OBSERVED	Being recruited in one of six universities	Not being recruited in one of six universities	Total
Gatekeepers	15	2	17
Externally Oriented	6	4	10
Internally Oriented	16	3	19
Inactive Researchers	12	21	33
Total	49	30	79

Table 34: Expected data for being recruited in one of best performing six universities

EXPECTED	Being recruited in one of six universities	Not being recruited in one of six universities	Total
Gatekeepers	11	6	17
Externally Oriented	6	4	10
Internally Oriented	12	7	19
Inactive Researchers	20	13	33
Total	49	30	79

5.7.4 Overseas Work Experience

Finally, possible relationships between overseas work experience of the researchers and their positioning regarding the projects that they are performing are tested. Overseas work experience refers to the amount of time spent working abroad for post-doctoral education in academic

institutions or for professional experience in the private sector. to check the relationship between the taxonomy consist of four groups and having overseas work experience binary data were used. Again, Chi-square test is performed instead of T-test. Based on the observed and expected data listed in following tables (Table 35 and Table 36), it is found that there is an association between the taxonomy and having overseas work experience (p=0.04)

Table 35: Observed data for overseas work experience

OBSERVED	Work experince abroad	No work experince abroad	Total
Gatekeepers	14	3	17
Externally Oriented	7	3	10
Internally Oriented	14	5	19
Inactive Researchers	15	18	33
Total	50	29	79

Table 36: Expected data overseas work experience)

EXPECTED	Work experince abroad	No work experince abroad	Total
Gatekeepers	11	6	17
Externally Oriented	6	4	10
Internally Oriented	12	7	19
Inactive Researchers	21	12	33
Total	50	29	79

Looking at the overseas working experience of the population, a striking result can be seen: 58% of gatekeepers have more than 2,5 years of international work experience. Thanks to the contribution of the overseas work experiences of these individuals, it is assumed that they are able to sustain their international connections.

In the meantime, global work experiences of those involved only in international research projects were below the initial expectations. In fact,

researchers who work at the only local level put more effort into developing additional international links. It can thus be said that locally engaged researchers are progressing better that externally oriented researchers in terms of the rate of extending international linkages.

5.8 Elaboration on Quantitative Findings

From the work done thus far:

- It has been demonstrated in this study that where international collaboration and national level research activities are discussed, the general picture can be framed in four groups, as expressed already.
- Contrary to initial expectations, a significant portion of those engaged strongly in international cooperation are active at the local level, as well. They even provide a significant contribution to their research environments within the context of involvement in governance mechanisms via academic research programmes and contribution to R&D capacity development in the private sector.
- A small fraction of researchers are visible only from externally oriented actions. It seems that they are lacking a focus on the national basis.
- Researchers active only on a national basis in the period of 2003–2006 showed progress at the international level. The quantitative findings imply that, after a while, such researchers wanted to interact externally with the global players.

So, why is such grouping happening? The most meaningful results here show that it is related with overseas work experience and the ecosystem conditions of the university in Turkey at which a researcher works. A suitable research climate established by a university is a notable positive variable for better project performance at both studied levels. It is also expected that such universities are probably following set strategies and have certain principles for choosing faculty with the most suitable academic profiles.

The basic question that constitutes the starting point of this thesis is to what extent ICT researchers engaged in international collaboration are active on a national basis. Quite frankly, it was expected that many of these people were not concerned significantly about national issues. It can be said that most of the quantitative results are contrary to these initial expectations.

The most prominent actors in international collaboration for the period of 2003–2006 were also the researchers who led on the national basis with respect to their national project portfolios. Coupled with engagements in strengthening the public and private sector research capacity, as well, this situation continued in the period 2007–2013. Taking into account these findings, it can be said that gatekeepers are the most valuable and efficient group of researchers in the ICT sector in Turkey.

Looking at the performance of those who were engaged in only global collaboration in the period of 2003–2006, they remained relatively behind the gatekeepers and internally oriented researchers, and the number of researchers in this group is declining slightly.

The results show that researchers who were active mostly on a national basis in the period of 2003–2006 then took steps to improve their international cooperation activities in 2007–2013. This finding corresponds to TÜBİTAK's visions to strengthen international ties, starting from initial steps to make Turkey a part of the ERA and opening the Turkish Research Area to the world. It is argued that enhancements of international links should be triggered with additional steps in following years, because the descriptive analysis clearly demonstrated that most of the Turkish universities are lacking project-based ties with their counterparts abroad.

Initially it was expected that some universities might have originally been more isolated than others because of infrastructure, collaboration records of its researchers, and lack of roots favouring the collaborative research culture.

The findings correlate with these initial thoughts, whereby the research capacity of a university is statistically significantly related to better project performance. However, at the same university, people with similar backgrounds showing different performances is an open area for further questioning in in-depth interviews. The only valuable quantitative finding on the individual level is about the relationship between project performance and post-doctoral research or professional work experience abroad. Those who have over 2.5 years abroad beyond PhD studies have more appetite than others in terms of project development. Moreover, in the case of six universities, the institutional research ecosystem can also contribute to finding relevant expressions about the factors influencing the project performance. However, it should also be noted that the international collaboration level of other universities is very low.

5.9 Qualitative Analysis

This research is about the further collaboration dynamics and research-related performance of ICT researchers engaged in international collaboration. Data limitations prohibit benefiting fully from quantitative methods, and so qualitative methods are complementary to understanding the processes related to local versus international collaboration and also the determinants lying behind the heterogeneous performance of researchers with similar backgrounds. Moreover, prior research deploying quantitative methods provided evidence on the individual level that needs to be investigated deeply on the institutional level. Hence, along those lines, a case study method has been implemented. According to Yin (1994), a case study is empirical research that investigates a contemporary phenomenon within its real-life context. It provides the collection of detailed and multi-dimensional data about a small number of cases to answer specific questions (Eisenhardt, 1989; Gillham, 2000). Yin (2009) also states that evidence of multiple case studies is more convincing and therefore the study will be regarded as more robust.

5.10 Steps in the Qualitative Study

In the quantitative part of this thesis I have shown that the project performances of ICT researchers are heterogeneous, and so they were classified into four groups in terms of combinations of local versus international projects. It was also shown that researchers engaged intensively on both levels are concentrated at a limited number of universities. Based on descriptive statistics, it was seen that six universities (METU, İTÜ, Koç, Sabancı, Bilkent, and Boğaziçi) in Turkey have conducted 69% of all funded ICT projects that have international dimensions. Initially it seems that they are clustered, but their intensity of project portfolios is heterogeneous at the national and international levels. Hence, although they are presented as successful cases, they represent a mixture of universities: some are dedicated more to international collaboration; some are still locally oriented but somehow generate the biggest portion of the ICT project capacity of higher education in Turkey. Moreover, we need to understand why researchers with similar performances differ with respect to their project portfolio, and so we need to capture the issues and attitudes related to such kinds of variations among researchers. Taking into account the open issues from the quantitative part, the qualitative study is based on semi-structured interviews focused on six university level case studies. The main themes covered during the interviews are listed below:

- Policy for recruiting researchers,
- Motivations to conduct a research project,
- Trade-off concerning publishing versus conducting projects,
- Trade-off concerning national versus international collaboration,
- Performance-based evaluation system, and
- Reasons for differences in performances of researchers with similar backgrounds.

Prior to each interview, the quantitative findings about that university that could provide ground for more detailed questions were reviewed. For example, in the case of METU, the declining performance in international ICT collaboration was questioned, while in the case of Koç University, the focus was on unlocking policies behind the more intensive focus on international collaboration.

In the interview stage, first we tried to reach the vice-rectors responsible for research policy; if that was not possible, we shifted to other related administrators responsible for the coordination of research at the university level or senior people knowing the dynamics of the ICT departments at the university. Luckily it was possible to interview four vice-rectors, one contact person for handling relations with the policy department of TÜBİTAK, and one senior researcher who has a deep understanding of the history and dynamics within the ICT departments of his university. The interviews were conducted on the phone, and at initial stages information was provided about the findings from the quantitative part for this study, mentioning the standing of the interviewee's university.

In other words, interviews were performed on the basis of guided conversations; at the beginning the overall picture of the study and its scope were provided, and then interviews continued with more detailed questions to get insights from the university representatives about institutional level policies, principles, and strategies. I tried to extend the conversations on a mutually agreed basis, because the probability of getting more useful information then increases.

The length of interviews ranged from 50 minutes to 2 hours. In order to obtain more insights, none of the interviews were digitally recorded, but each valuable detail was noted simultaneously in a written form. After each interview, the transcribed text was re-read carefully and shared them via e-mail with the advisor of this thesis to allow timely recommendations regarding the follow-up steps. Sharing the details about each interview provided an

opportunity to revise and update the general findings from the in-depth analysis. During the coding phase, the grounded theory building approach was followed (Eisenhardt, 1989; Glaser and Strauss, 2009). Primarily the approach Eisenhardt (1989) was followed where it was said that "*The inductive case method suits research that poses 'how' or 'why' questions, involves complex causal links, and seeks to generate novel theory that is empirically testable*". During the interpretation of findings, the work of Whetten (2000) was followed, as well (Figure 7).

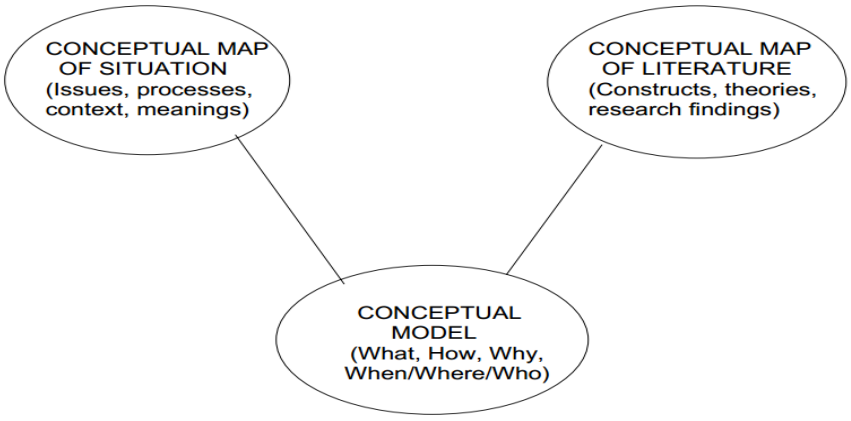


Figure 7: Conceptual model of grounded theory (Source: Whetten, 2000)

Linking the conceptual issues with empirical findings was a kind of bridging activity covering the literature on European R&D networks, research policies for higher education, STI indicators, local buzz–global pipelines, etc. Finally, findings were categorised into six levels (Table 37) with the aim of forming a ground for Chapter VI and being able to present and discuss findings of the qualitative research from a policy-making perspective.

Table 37: Findings of the qualitative study

	Recruitment Policy	Motivations for Research	Publishing vs. Projects	National vs. International Engagements	Performance-Based Evaluation	Explanations for Differences in Research Outputs
Bilkent University	Strict rules for selecting researchers (i.e. publications in high-impact journals, reference letters) Marie Curie seen as useful tool to attract talents	Evaluation committee for seeking the research components Softening the rules because of entrepreneurship index Access to EU level infrastructures Awareness-raising campaign led by the Rector Projects offer carrots like best graduates and incentive bonus	Optimal trade-off between publishing and research projects Special care for potential star scientists Technology- and product-oriented projects seen as strategic	Recently adopting strategies for shifting their focus to national projects because of pragmatic reasons (less bureaucratic burdens, ease to get funding, new mechanisms for big projects) Initial steps to set strategic initiatives with private sector (e.g., AVEA)	Merit-based performance system Salaries are flexible depending on scientific outputs A young Asst. Prof could receive higher salary than a senior Prof.	It should be elaborated case by case Having a big team triggers the needs for projects in order to sustain Focusing on one and only one specific topic (i.e. 3DTV)
Boğaziçi University	Rather than a policy they have principles coming from the historical roots of the university (do not recruit graduates w/ external experience, need for consensus for recruiting a certain researcher, sustaining the independence of the university)	Competition triggers the motivations for having funded projects Matching funds for pre-project phases	Primary focus for publishing papers BAP fund is enough for satisfying publishing requirements for academic tenure No favours for project makers	Projects are seen as engagement activities Indifferent toward national vs. international No priority to lead 1007 projects with societal objectives International projects preferred to 1007 projects A lack of institutional coordination for managing project portfolios	No need for performance-based system, because not possible to change the salary	Personal factors and different career paths have an impact on research outputs: Entrepreneurial spirit Being engaged with networks (i.e. international or industry linkages)

Table 38: Findings of the qualitative study (cont'd)

	Recruitment Policy	Motivations for Research	Publishing vs. Projects	National vs. International Engagements	Performance-Based Evaluation	Explanations for Differences in Research Outputs
Sabancı University	Strict rules for selecting researchers --- competence level checking Consulting to prominent researchers Thematic area Individual and independent research capability Non-academic working experience	Individual research funding based on performance Soft money Bo punishment, just for motivation Stick and carrot approach for Assoc. Professors (3 or 5 assessments) Assessments create competition among researchers for funding opportunities	Dominant policy favouring publication Emerging policy on big projects (especially for defence sector)	No differentiation, but most successful in national projects No clear strategy for promoting international projects except project money provided for time allocated in an international collaboration project Overheads of FP projects are seen as attractive tool (complaints about the national approach for not covering the overhead spending)	Well-defined merit-based performance system If performance is not satisfactory, termination of the contract	Soft skills and personal factors have an impact on research outputs Moreover there are disgruntled researchers who are sceptical about the national system
Koç University	Policy to select right people while providing the appropriate ecosystem for research Strict rules for selecting researchers: -having graduated from best universities -publications during PhD study at journals w/ low acceptance rate -post-doc experience	No direct reward or punishment mechanisms It is important to select the best people and provide appropriate ground to play Start-up fund provided for the first year	Primary focus for publications at best journals However, playing an important role in world class projects also contributes to tenure	Focus on world-class international projects Policy for collaborating with best research universities Engagement with industry is also important (1003 and 1007 programmes provides good ground for collaboration with private sector)	Well-defined merit-based performance system If performance is not satisfactory, termination of the contract	Two reasons: -Soft skills and personal factors (i.e. being a demanding researcher) -Research discipline (some topics in ICT are theory-oriented while others are practise-oriented)

Table 39: Findings of the qualitative study (cont'd)

	Recruitment Policy	Motivations for Research	Publishing vs. Projects	National vs. International Engagements	Performance-Based Evaluation	Explanations for Differences in Research Outputs
METU	Rather than an explicit policy they have principles coming from the historical roots of the university: -dense network with graduates - job market paper presentation - a sense of belonging to METU and corporate culture	Competition triggers the motivations for having funded projects No clear strategy, but "research in the air" environment Guiding senior academics to engage with technopark companies Performance-base-department budgets for creating and sustaining linkages	Primary focus for publishing papers because of the tenure procedure (high impact publications trigger projects) But recently shifting to a differentiated policy assigning equal weights to academic research, teaching, entrepreneurship, and engagement with society	Recently adopting strategies for shifting their focus to international projects and especially to Horizon 2020. The diminishing international collaboration reflected by drastic increase in national funds, a lack of institutional approaches to leverage multipliers, and not having an international engagement strategy	Incentives for best performing researchers and departments rather than a tough performance system Publications, patents, theses, design of new courses, and money generated from contract research are part of the incentive system	Systemic reasons: - lack of a strategic approach to trigger internal collaboration (it is expected that central coordination will decrease such differences)
İTÜ	Rather than an explicit policy they have principles coming from the historical roots of the university (preferring researchers with PhDs from abroad, being a preferred university because of its brand value, and advantages of being in İstanbul)	No clear strategy for the promotion of research projects Recently catalysing the TTO offices to promote conducting of research projects	Indifferent between publications and projects An emerging priority issue is about patenting activities (they think that patents attributed to İTÜ researchers are very small in number)	Indifferent between national and international projects; no matter whether it is international or national, it is important to bring funded projects More successful in national projects Government does not follow balanced approaches between int. and national mechanisms (too many national mechanisms)	No need for performance-based system, because not possible to change the salary	Soft skills and personal factors (connections boost the international projects) Research experience in foreign countries (PhD fulfilled at an EU university increases the chances to find consortia to be funded by the EC)

CHAPTER VI

POLICY RECOMMENDATIONS

This thesis has proposed and empirically examined the taxonomy of local buzz and global pipelines in the context of ICT research in an emerging economy. In this chapter, a multi-level framework will be incorporated with emphasis on individual skills and practices at institutional and national bases. Here, we review the main findings of the research and discuss policy options at three levels (micro, meso, and macro levels).

The aim of designing policy recommendations is to increase the number of ICT gatekeepers in the higher education sector and to improve the added value of the ICT ecosystem. Some implications derived from the study can be summarised as follows:

(i) The project-performing intensities of ICT researchers are heterogeneous. The empirical investigation suggests that there are significant differences in recent national and international project portfolios of Turkish ICT researchers that were involved in international collaboration between 2003 and 2006. Generally, the observed differences suggest the need for differentiated policies for different clusters concerning their degree of local and global focus. Thus, a holistic perspective which takes into account the variety of profiles should be adopted instead of one-size-fits-all policies.

(ii) Officials and policy-makers should be aware of such clusters of researchers that are just active in one dimension (who are active internally or externally only). More studies must be conducted focusing on different segments of the population. Several methods

should be found to activate the potential of those performing under their potential.

(iii) Despite the growing funding for international collaboration in Turkey, the number universities engaged in ICT is still low.

(iv) Low level of collaboration under European Framework Programmes should be addressed by internationalisation strategies developed by universities that can be supported by public authorities on a performance basis.

(v) The number of gatekeepers should be increased. Hence, policies that encourage international collaboration will contribute to the knowledge stock of the country since it is shown that gatekeepers create positive outcomes at the local base as well. Such policies should not limit the project involvement of gatekeepers at the national level. The need to remove quotas prohibiting managing more than two ARDEB-funded projects simultaneously is commonly mentioned by vice-rectors due to the fact there are qualified researchers who can manage more than two projects at the same time.

(vi) As shown in this study, only six Turkish universities are active in international ICT collaboration. The number of internationally active universities can be increased by twinning those universities with at least another six having the potential to be engaged in international activities.

(vii) In the previous 10 years, the government invested heavily in research centres and central research laboratories. However, the international level of performance of those centres is negligible. Special policies to activate the potential of research centres are needed.

(viii) The number of project-based support mechanisms has been increased recently. There are several available tools that allow researchers to submit proposals and apply for grants. It is assumed that such a variety of tools increases the knowledge that is circulated. However, the governance mechanisms from which policy-makers can acquire valuable information are not sufficient. More mechanisms must be developed to get feedback from project investigators.

Based on the experiences shared during the in-depth interviews, several recommendations have emerged. These recommendations can be considered at the individual (micro), institutional (meso), and system (macro) levels. The findings can be incorporated in 16 recommendations at multi-level dimensions, which are presented in Figure 8.

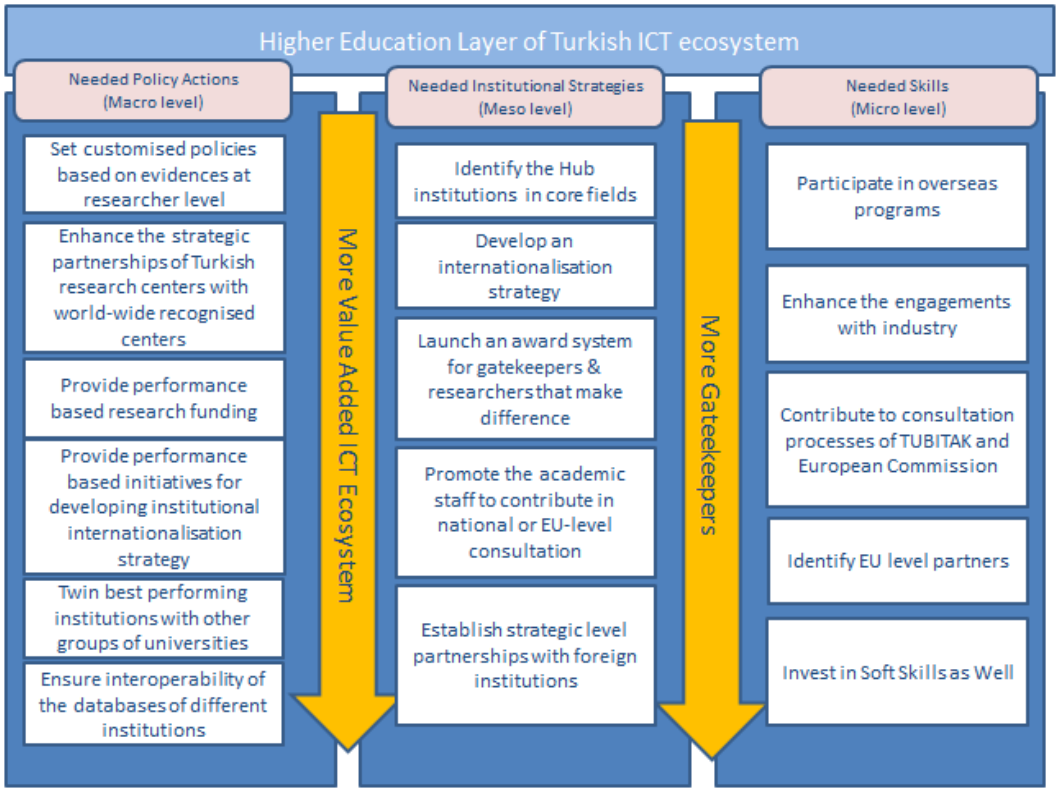


Figure 8: Sixteen policy recommendations at three levels (macro, meso, micro)

6.1 Macro-Level Policy Recommendations

Macro-level recommendations cover the nationwide policy issues regarding the ICT research in Turkey. Here we can mention six policy options:

- Set customised policies based on evidence at the researcher level,
- Enhance the strategic partnerships of Turkish research centres with world-wide recognised centres,
- Provide performance-based research funding,
- Provide performance-based initiatives for the preparation of institutional internationalisation strategies at universities,
- Twin the best-performing institutions with other groups of universities, and
- Ensure interoperability of the databases of different institutions.

6.1.1 Set Customised Policies Based On Evidence at the Researcher Level

Often governments launch mechanisms to enhance project-performing culture or innovation capacity as a whole, where their objectives are very broad. Such mechanisms do not specify the needs of heterogeneous groups as stated in this study. Different approaches and policies should be developed for different researcher profiles, besides the more traditional one-size-fits-all policies. Such new types of policies must be based on evidence from data-mining studies at the researcher level. Instead of replacing all the current policy, a new kind of mixture of policies should find breadth in the policy-making sphere. Evidence-based policies rely on extensive data processing, such that there is a clear need to strengthen the infrastructure for storing and handling databases. It is believed that placing evidence-based approaches at the heart of policy-making will provide ground for ex ante impact analysis and then ease the measuring of the outcomes of the mechanisms.

Here we can examine a case about evidence-based policy-making within the boundaries of the local buzz–global pipelines approach. In this case, Turkish participants in the FP6 IST theme are clustered with respect to their local–global activities concerning the boundaries of R&D. A bi-dimensional index was built to map the global versus local activities of the sample. The bi-dimensional index separates the participant profiles into nine categories with respect to their local–global orientation, focusing on the time interval between 2004 and 2012. The index allows establishing different groups with respect to the objectives. Every organisation has a coordinate code showing its degree in terms of the local and global dimensions of its focus. For example, we can make rankings based on how different policies are reflected in reality.

Rather than combining local and global level activities in one pot, the index treats them separately as two different dimensions. It is proper to say that the axes are not mutually exclusive; they have interacting features.

In our case, in order to position the local and global dimensions of an entity, three determinants are developed. The first determinant is the projects stock of each participating entity. The performance of a research group or a firm can be quantified in various ways. Two such ways are the ability to initiate projects and the amount of acquired project funding (Nokkala et al., 2011). The more projects that they have, the more knowledge creation activities they are engaged in. For each axis, potential programmes were identified (i.e. funding mechanisms), to which researchers and firms can apply for project funding. These are programmes that have national or international dimensions. Pragmatically, programmes were focused on for which sufficient and reliable data were obtainable. These were mainly European Commission and TÜBİTAK programmes, as shown in Table 38.

Table 40: Programmes and mechanisms utilised in the pilot study

Dimensions	Programmes/Mechanisms
Global	FP6, FP7, Eureka (TÜBİTAK 1509), COST (via TÜBİTAK 1001), bilateral programmes (via TÜBİTAK 1001)
Local (National)	**Primary Set:** TÜBİTAK 1002, TÜBİTAK 1002, TÜBİTAK 1007, TÜBİTAK 3501, TÜBİTAK 1501, TÜBİTAK 1503, TÜBİTAK 1507 **Secondary Set:** FP6, FP7, EUREKA, COST (if there is more than one Turkish organisation in the same project)

A programme can have both national and international dimensions. In such cases, the said programmes are added to both axes (local and global axes). For example, if an FP6 project has more than one Turkish partner, it is treated as providing an opportunity for local knowledge flow as well as a possibility for knowledge exchanges among international partners at the EU level. If an international project has only one Turkish partner, it is counted only for the global activity axis and is treated as a project with limited local deployment opportunity.

The second determinant of the model is the tendency of governmental or EU Commission authorities to benefit from the participants' know-how. In contrast to the first dimension, it is a kind of a "push" approach, while the first dimension can be considered as a "pull" activity. In an innovation ecosystem with intervention by governmental authorities (national or, in the case of Framework Programmes, transnational), the researchers and R&D

firms usually “pull” the project proposals for their needs, while in other cases the authorities may “push” them towards different mechanisms.

In a modern innovation system, the project selection phase of project proposals is normally done via a panel system. In order to avoid and minimise bias in the selection process, panels are constructed with experts who do not have organic relationships with the funding authorities. Such a system also provides an opportunity to exploit the previous experiences of researchers who took part in funded projects. In other words, thanks to such mechanisms, public authorities build governance structures for interactions with researchers and firms in the ecosystem.

In the Turkish system there are three additional mechanisms that are quite similar to the panel system with respect to the exploitation of knowledge. Those are the reviewing system, referee system, and executive committee members of special fields supported by TÜBİTAK.

All four of these mechanisms increase the potential to exploit and circulate the knowledge obtained from research projects already conducted or being conducted. At the international scale, evaluators’ data for FP6 and FP7 are utilised to see how EU-level bodies reflect the Turkish participants from FP6 IST in their governance structure.

The third dimension of the model reflects the cognitive proximity of R&D performer bodies. It is advantageous for a researcher or a firm to have access to a diverse set of knowledge sources (Rodan and Galunic, 2004). In line with that here, it is aimed to state cognitive patterns regarding local and international focus. Similar to the other two dimensions, for each participating entity a coordination code of two axes was developed to assess their degree of focus. Under each axis, the number of involvements of each participant in governance mechanisms is deployed as a proxy to

judge the participants' space of focus. It is expected to find heterogeneous degrees of cognitive proximities in terms of an actor's concentration on local buzz or global pipelines. For example, if an entity uses mostly international collaboration mechanisms, it means that the entity has a more intense focus on international activities. Of course, one entity can have balanced degrees in terms of internationalisation and local deployment. For those trying to focus on local and global activities simultaneously, their degree can be modest, balanced, or excessive in terms of the positions of other Turkish participants. Several alternatives can be framed in a 3×3 matrix as given in Table 39.

Table 41: Taxonomy for identifying the degree of local–global focus

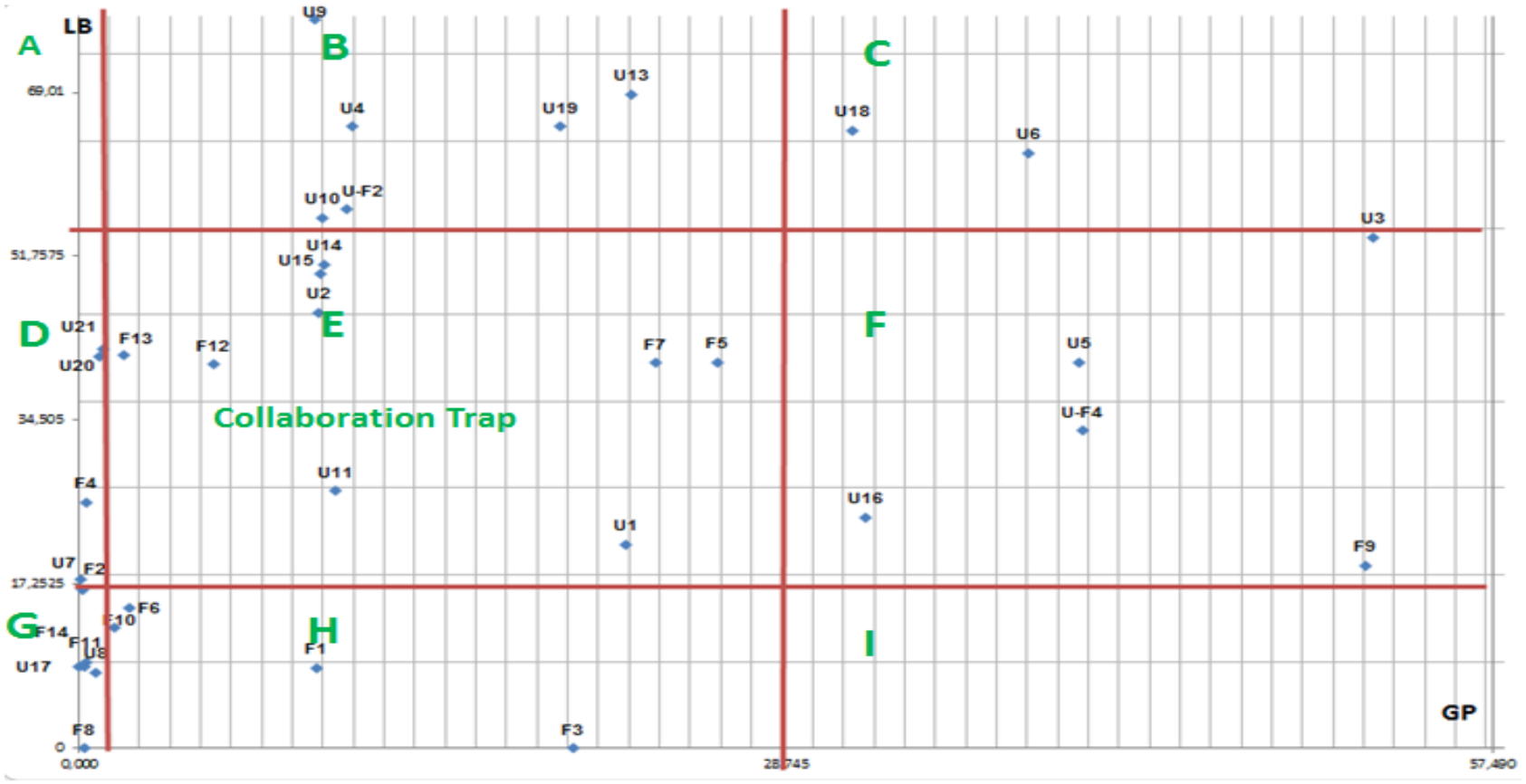
(A) **Excessive localisation, modest internationalisation**	**(B)** **Excessive localisation, moderate internationalisation**	**(C)** **Excessive localisation, excessive internationalisation**
(D) **Moderate localisation, modest internationalisation**	(E) Moderate localisation, moderate internationalisation	(F) Moderate localisation, excessive internationalisation
(G) **Modest localisation, modest internationalisation**	(H) Modest localisation, moderate internationalisation	(I Modest localisation, excessive internationalisation

Based on the matrix, we can set 9 quadrants to bridge local and global collaboration dimensions of Turkish FP6 participants. The sample mapping is shown in Figure 9.

The results of the clustering provide an opportunity to characterise each quadrant and make judgments about the findings. Sample judgements for the pilot study are listed in Box 1.

Such types of evidence-based clustering allow policy-makers to be aware of micro-level dynamics. Benefiting from the case study, we can state that performance of FP6 IST participants tends to be heterogeneous from the perspective of project stock, involvement of governance bodies, and degree of cognitive focus for local or international collaboration. This type of approach can be utilised in many forms; for example, findings and policy implications can be using for tracking the performance of researchers, or they can be useful in setting the strategy for Horizon 2020, as well. Detailed information regarding the dataset and methodology is provided in Appendix B.

Figure 9: Clustering of 39 Turkish organisations with respect to local–global dimension of collaboration networks, 2004–2012



[43]U1,U2...Un: Partners from universities; F1, F2,...Fn: Firms; U-F1, U-F2...U-Fn: Spin-offs founded by university researchers.

Box 1: Judgements for the pilot study

The first group (Group A) is characterised by relatively modest internationalisation but excessive localisation. There is no entity lying within this set.

The second group (Group B) is characterised by excessive localisation and moderate internationalisation. The research groups and firms falling into that group manage both local and international links, but local links seem to be more extensive. Most of them have FP7 or EUREKA projects, which mean that they are sustaining their international ties. However, they focus on limited international collaboration tools while managing several local collaboration actions.

The third group, Group C, contains the positive extremists. This is the most successful group in terms of international collaboration. Three of the members of this group lie very far away from the rest and are not able to be shown in Figure 6.2, while 60% of the international project stock of the sample belongs to five organisations in that group. These firms prefer to internationalise through the EUREKA programme rather than FP6 and FP7. This a pragmatic approach, but on the other hand it gives clues that they are not doing cutting-edge research. All firms in this group are software integration firms. Focusing on new international projects is simply a way of life for them. This raises questions about their local added value. The findings provide interesting insights about local–global knowledge dynamics in the case of organisations that do not focus on the local deployment. They do not have local focus, but they diffuse more than most of the locally oriented firms in the set. This leads one to say that excessive international collaboration causes certain local-level deployment, as well.

Group D contains those who are not able to sustain international linkages but are doing well on a local basis. Three of the members of this group state that the reason for not being able to sustain global links lies in external reasons like having other professional duties that prevent the conducting of FP projects, or a lack of promotional policies, which can be developed by TUBITAK and techno-park management.

Members of Group E have both local and international links at a moderate level. They are experienced in the Framework Programme and most of them took leading roles in FP projects. Taking into consideration the case of Group E, I state that there are firms and research groups facing the risk of falling into this collaboration trap. Although these participants are currently at humble levels in R&D and collaboration, they have the potential to become rapidly involved in knowledge exchange activities, but these participants are not at the frontier points of collaboration. They are performing below their potential, such that they eventually stagnate after reaching moderate levels of R&D success rather than pushing for more R&D and collaboration. They prefer to perform according to their present strategies.

Group F primarily comprises researchers who prefer international collaboration rather than local exploitation. Researchers who know the members of this group state that they love to be involved in projects about new concepts and new frontiers in ICT, but they are challenged in applying the internationally available knowledge on a local basis.

Nine of the participants of FP6 IST fall into Group G or just onto the boundaries of Group G. Eight of them were not involved in any FP or TUBITAK projects in the last nine years. The main findings about this group are expected to contribute to the debate about the added value of EU Framework Programmes, which are mostly dominated by industrialised countries. The case of Group G shows that participation profiles from a country not at the core of EU R&D networks are strictly heterogeneous. While there are well-integrated organisations that sustained their involvement in local and international networks, like Group B, Group E or Group F, there are entities that disconnected themselves from local buzz or global pipelines in terms of R&D activities even though they took part in R&D networks under FP6.

Another unique point about Group G is that all of the partners falling into that group were engaged in STREPs, the small-scale tool of FP6.

Similar to Group G, Group H is also a somewhat disconnected cluster in terms of R&D activities. These actors are involved in international R&D activities, but they seem to be performing below average. Group I does not include any organisations from our set.

researchers from TÜBİTAK). It is expected that researchers working in these centres have the potential to establish more international linkages. Infrastructure and human power come together in these centres, and so possibility that these groups will be engaged in larger-scale projects is higher than in the other parts of the ICT ecosystem. The case of Boğaziçi University clearly indicates that infrastructure support for a research centre provided an enabling environment, which boosted the number of international projects (for a 214% increase in number of international projects between 2007 and 2013). Based on their experience, a representative of Boğaziçi University states that “research centres should be triggered more to take a key and central role in the innovation system”.

However, these actions for international collaboration are taken mostly at individual levels. None of the university representatives mentioned institutional steps taken to link their research centres, except Sabancı University, which established a strategic partnership with MIT. Therefore, helping those institutes on a pragmatic basis where it is important to diagnose the strengths of those centres, clarifying the best possibilities for setting international linkages, and catalysing dialogue with public and private authorities seem to be rational steps.

In that sense, the South Korean and Singapore experiences are interesting in that they are trying to set initiatives to draw the divisions of internationally leading research centres such as Max-Planck, Pasteur, and Fraunhofer to their countries.

For example, there are various programmes to draw some of the research centres that perform world-class research to open divisions in South Korea. The aim is to diffuse the global research expertise to South Korean researchers. Below three Korean programmes are listed:

- Institute Pasteur - Korea Support Program[45]
- Aim: Development of new medicine for human health
- Targeted Technology Area: Biotechnology
- Budget: 12.5 Million Dollars

- Max Planck Korea/POSTECH Research Institute Program
- Aim: Development of a joint laboratory with the Max Planck Institute within POSTECH university
- Targeted Technology Area: Material Technology
- Budget: 1.8 Million Dollars

- Programme to Draw Leading Research Centres to Korea
- Aim: To support the establishment of joint research centres with the best research centres
- Budget: 450–900 thousand dollars per research centre
- Duration: 6 years (2 years + 4 years)

Similar support is provided from Singapore's authorities to their universities for hosting world-class research. Under the CREATE (Campus for Research Excellence and Technological Enterprise) program[46], 10 research centres that are established in collaboration with leading universities in the world are supported in performing advanced research in specific fields. Centres that are supported by the CREATE programme have a budget that is to be used for human resources and research infrastructure. The first CREATE centre was realised with the Massachusetts Institute of Technology based on the trust that was formed by an alliance agreement with more than 20 years of background. This successful collaboration has

[45]Gathered from http://www.nrf.re.kr/nrf_eng_cms/show.jsp?show_no=98&check_no=89&c_relation=0&c_relation2=0 and accessed on 22 August 2013.
[46]Gathered from http://www.nrf.gov.sg/nrf/otherProgrammes.aspx?id=188, accessed 22 August 2013.

facilitated other leading universities to come to Singapore in the following timeframe. While the research that is performed by the CREATE centres does not directly aim for commercialisation, this result can be attained with the assistance of the technology transfer offices. The patent rights that are obtained by the local (Singapore) universities and the foreign universities are realised on a 50%–50% basis. The support that is provided by NRF to the 10 research centres varies from centre to centre. An amount of 47 million USD for 5 years was allocated to the TUM-CREATE centre, which was visited during the study visit. In the second phase of the CREATE programme, it is expected that financial contribution from the private sector will be sought.

In line with the Korean and Singaporean experiences, a programme can be developed by TÜBİTAK to support strategic level partnerships of researcher centres funded by the Ministry of Development between 2003 and 2011.

6.1.3 Provide Performance-Based Research Funding

It was particularly highlighted by the representatives of state universities that the central system is prohibiting them from performing better in terms of research outputs, or, in other words one of the reasons for low levels of international performance is the burden regarding not being able to recruit staff to increase the visibility of the university at the EU level. Therefore, they want to be more autonomous in managing financial resources.

Several reports state that more autonomy should be linked to monitoring processes and fulfilment of research targets of universities[47]. For example, New Zealand is assessing the research performance of tertiary education

[47]http://ec.europa.eu/education/higher-education/doc/funding/sum_en.pdf
http://www.utwente.nl/mb/cheps/publications/Publications%202010/MODERN_Funding_Report.pdf
http://www.oecd.org/gov/budgeting/43494478.pdf
http://soc.kuleuven.be/io/egpa/org/2011Roem/papers/paper%20Beerkens.pdf

organisations and then funding them on the basis of their performance funding process[48].

Similarly, in Turkish higher education system, more autonomy may not be granted unless the universities reach their targets set by the public authorities. Deploying wise practices may speed up the smooth transition into a performance-based system. Below, three semi-level proposals are made which could be put into practice via the Ministry of Finance, Ministry of Development, and TÜBİTAK:

- Conducting a competency assessment for all types of research institutions, starting from research centres settled at universities, funded by the Ministry of Development, and providing funding with respect to their competency level.
- Paying overhead based on different percentages with respect to the project portfolios of state and foundation universities
- Removing quotas for high-performance researchers in TÜBİTAK's support programs.

6.1.4 Provide Performance-Based Initiatives for the Preparation of Institutional Internationalisation Strategies at Universities

In-depth interviews show that none of the universities have international engagement or internationalisation strategies. They do not have clear targets regarding giant funding programmes like FP7 and upcoming Horizon 2020 projects; in other words, they do not have a strategy for international collaboration. Moreover, derived from the overall findings of the six interviews, disappointment regarding international collaboration is related to insufficient institutional structuring (i.e. separate branches at the universities for the coordination of research, burdens to recruit competent experts with non-academic backgrounds).

[48]http://www.tec.govt.nz/Funding/Fund-finder/Performance-Based-Research-Fund-PBRF-/, accessed 22 August 2013.

The efficiency of the governmental funding for international collaboration can become more inclusive if it is reflected strategically at the meso-level. The statistics show that 22 universities in Turkey constitute 91% of all international collaboration in ICT, while 69% of international collaboration is performed by only 6 universities. Therefore, in order to activate the international focus of Turkish universities, the government, on a performance basis, may provide support for developing international strategies.

6.1.5 Twinning the Best-Performing Institutions with Lagging Universities

As mentioned before, international collaboration in ICT is centred on six universities. In an environment where so many funds are available, other universities also need to enter the competition. Therefore, balanced trade-offs should be created between leading and laggard universities. Present findings state that universities like Kocaeli, Yıldız Teknik, Dokuz Eylül, Hacettepe, Fırat, Anadolu, TOBB ETÜ, İzmir Yüksek Teknoloji, Yeditepe, Gebze Yüksek Teknoloji, Ege, Süleyman Demirel, Işık, Erciyes, Pamukkale, and Özyeğin have the capacity to become engaged more intensively in international collaboration.

It is important to twin the best-performing universities primarily with those that have a capacity to conduct international collaboration. Such an effort would be most probably helpful in increasing the funds received from upcoming Horizon 2020 programs.

If such twinning becomes successful, it will be coupled with pairs consisting of a university and a private sector company. It can be stated that not only do the inter-linkages between the private sector and successful universities in FP6 IST facilitate the participation of private sector actors in EU projects, but they also enable the management and maintenance of previously connected networks with the aid of the experience of the university actors. It

can be argued that the most visible Turkish universities in the EU ICT ecosystem can play a pivotal role in transforming the Turkish private sector, and particularly SMEs, in the context of the Horizon 2020 programme. Therefore, enhancement of partnerships between successful Turkish universities like METU, Bilkent, Sabancı, and Koç and private sector institutions that perform research activities could be an alternative to trigger involvement in funded EU projects.

6.1.6 Ensure Interoperability of the Databases and Data Quality of Different Institutions

In this study, I have tried to match different sources. This was done mostly manually because there are no possible ways yet to combine researchers' data from different sources. Because of the present state of databases, we cannot always do exactly what we want. For example, it was not possible to properly match ICT researchers' name with their patent data on a chronological basis. Moreover, it was not possible to include the consultancy services provided by the population in funded TEYDEB projects. Similarly, we could not benefit from bibliometrics on international collaboration dynamics of the population because of time limitations.

In order to make better evidence-based policies, playing with and manipulating data ensuring the interoperability of the databases and data quality of different institutions is crucial. In a sphere where TÜBİTAK's funding for bilateral and multilateral collaboration, excluding FP6 and FP7, increased 19-fold, the future policies on international collaboration should be developed based on evidence with the contribution of well-working databases. Therefore, comprehensive effort should be made toward developing sustainable systems to match different data sources and ensuring the availability of data for national and international collaboration dynamics.

6.2 Meso-Level Policy Recommendations

At the meso-level, recommendations for Turkish universities are being developed:

- Identify the hub institutions in core fields,
- Develop an internationalisation strategy,
- Launch an award system for gatekeepers and researchers that make a difference,
- Encourage academic staff to contribute to national or EU-level consultation mechanisms, and
- Establish strategic level partnerships with foreign institutions.

6.2.1 Identify the Hub Institutions in Core Research Fields

One of the findings of the in-depth interviews is that the most successful universities do not have a clear view about what are the best possible EU-level partners with which to collaborate. Framework Programme projects are heavily dominated by a small number of hub institutions including Fraunhofer, CNRS, the Ecole Polytechnique Federale de Lausanne, Philips, Nokia, Siemens, and France Telecom (Wagner et al., 2004; Malerba et al., 2006). These organisations serve to orchestrate research and facilitate the exchange of knowledge among peripheral groups. Hubs dominate both the connectivity between the research organisations from different participant countries, either member states or associated countries, and that between different technology areas and research disciplines (Malerba et al., 2006).

This issue was handled already by the METU-TEKPOL study on Turkish ICT profiles:

> *"Findings of this study on Turkish ICT sector imply that lack of networking of Turkish organizations with the EU ICT hubs inhibited achieving success in FP ICT Thematic Area. Because, the level of networking of Turkish organizations with EU ICT Hubs is not adequate, due to the fact that Turkish researchers have limited personal contacts with EU researchers while the structure of EU ICT RTD is based on preferential attachment rather than self-organizing networks. In that sense, accompanying actions aiming to facilitate more enhanced participation in EU ICT RTD were not effective enough to trigger Turkish participation since the emphasis in those supportive actions was given to awareness raising and informing activities (p.17)."*[49]

Therefore, universities should make more effort to identify the best possible partners among central organisations that serve as "hubs" in FPs. There are several reports[50] or databases[51] providing information regarding the hubs in ICT at the EU level. After obtaining the initial reports, it is believed that universities can identify potential partner at EU level.

6.2.2 Develop an Internationalisation Strategy

It can be stated that accompanying actions were not effective enough to trigger Turkey's participation in FP7[52]. While the overall funding from FP7 increased 215% in comparison to FP6, ICT funding increased just 22%. This situation can be attributed to lack of institutional policies for international collaboration in ICT and also to trade-off between

[49] Turkey ICT RTD Technological Audit Study Deliverable 9, accessed from http://stps.metu.edu.tr/sites/stps.metu.edu.tr/files/task9.pdf on 22 August 2013.
[50] OVERVIEW OF RESEARCH PROJECTS IN THE ICT DOMAIN 2012, accessed from https://ec.europa.eu/digital-agenda/sites/digital-agenda/files/Stream_2012.pdf on 22 August 2013.
[51] http://www.ist-world.org/, accessed on 22 August 2013.
[52] For example, the TÜBİTAK EU Framework Coordination Office took part in seven FP6 projects (HAGRID, IST-MENTOR+, IDEALIST34, Idealist7fp, IST World, EPIST, and CEEC IST NET) that aimed to help to increase, directly or indirectly, the participation of the country in FP6 IST. Another 11 Turkish partners took part in accompanying actions aiming to facilitate more enhanced participation in EU ICT RTD.

internationalisation versus local consultancy options stressed by METU, İTÜ, and Boğaziçi University representatives. The current trade-off accommodates the risk of lock-in and lack of ability to update the knowledge stock if over-embeddedness becomes a reality in the Turkish ICT ecosystem. Therefore, comprehensive internationalisation strategies at the institutional level are needed.

This is a complementary recommendation to the macro-scale views presented in a previous section. Internationalisation of the institutions should be seen as a capacity-building effort, to build more effective and sustainable impact at the national and international scales. As mentioned before, none of the six top institutions have an internationalisation strategy, and just METU has preparations to build a special strategy for the upcoming Horizon 2020 programme. It is believed that not only the six most successful universities but also all of the universities ranked among the first 20 should define and implement an institutional strategy for Horizon 2020. Setting clear objectives and scanning the research potential at the university level can help to align target-oriented actions and will serve to enhance research outputs of the university. Such kinds of planning for the near future will also map clearly the upcoming openings, avoid missed opportunities, and set the ground to fill the gaps in the knowledge stock of recent dynamics in ICT research.

6.2.3 Launch an Award System for Gatekeepers and Researchers that Make a Difference

The METU case provides a useful feedback regarding rewarding the well-performing scientists and departments. The METU representative stated that “regardless of the money they receive as bonus, the awarding mechanism has a pushing role”. He mentioned that “Your quartile of performance is shared with the others, so you push yourself to be better”.

Awards systems should be coupled with sharing best practices because it is a good way to improve research performance of lagging researchers by replicating successes throughout the university. At that point, the award mechanism of the University Economic Development Association[53] could be a benchmark for universities willing to establish such types of incentives. The association has several categories of awards including[54]:

- Talent Development
- Innovation and Entrepreneurship
- Community-Connected Campus
- Collaboration and Leadership
- Research and Analysis
- Talent Development
- Innovation and Entrepreneurship
- Community-Connected Campus
- Collaboration and Leadership
- Research and Analysis

Especially for the state universities, such mechanisms can be treated as performance tracking systems at individual and departmental levels.

6.2.4 Encourage Academic Staff to Contribute in National or EU-Level Consultation Mechanisms

The number of project-based support mechanisms has been increased recently. There are several available tools that allow researchers to submit proposals and apply for grants. It is assumed that such a variety of tools increases the knowledge that is circulated. TÜBİTAK and other institutes are trying to establish governance mechanisms for designing future policies. Recently the number of such mechanisms has started to grow rapidly. For

[53]http://universityeda.org/about-us/, accessed on 22 August 2013.
[54]http://universityeda.org/value-to-members/best-practice-sharing/, accessed on 22 August 2013.

example, from the beginning of the year, TÜBİTAK conducted 23 consultations in several fields. Most of the researchers perceive them as fatiguing duties or works that do not add any value. It should be note that most of new calls in the TÜBİTAK funding system are based on the outputs of the consultation processes, which are open for all research. Such types of new governance structures provide a window to influence future research priorities. Therefore, it is believed that if university management encourages researchers to take part in such discussions, it will enable more inclusive governance among universities and central organisations.

6.2.5 Establish Strategic Level Partnerships with Foreign Institutions

This in-depth study showed that most of the collaboration actions of universities are ad-hoc based or initiated at the researcher level. The only exception is the strategic partnership between Sabancı University and MIT. On the other hand, international collaboration has become integral to higher education in the 21st century, and perhaps nowhere is this more apparent than in the recent proliferation of international partnerships among colleges and universities (Foster and Jones, 2011). It is often advantageous to formalise collaborative links with foreign partners at the institutional level by recognising that they can turn into partnerships under Framework Programmes or other funding mechanisms.

During the interviews, the İTÜ representative highlighted the importance of EU-level connections mostly coming from researchers doing PhDs in EU countries. This situation implies the need for joint PhD programmes with EU institutions. TÜBİTAK's recent 2214/B-Joint Doctoral Scholarship Programme offers institutional level incentives. Within the scope of the new programme, Turkish students will be eligible to get TÜBİTAK funding for conducting joint doctoral training/research for up to 24 months in universities abroad in the fields of natural sciences, engineering and

technology, medical sciences, agricultural sciences, social sciences, and the humanities if institutional protocols are signed between Turkish and foreign universities.

6.3 Micro-Level Policy Recommendations

Micro-level recommendations are listed in seven points below:

- Participate in overseas programs,
- Enhance the engagement with industry,
- Contribute to consultation processes of TÜBİTAK and the European Commission,
- Identify EU-level partners, and
- Invest in soft skills, as well.

6.3.1 Participate in Overseas Programs

Findings of the quantitative study proved that having over 2.5 years of work experience abroad contributes to having a more comprehensive project portfolio at the researcher level. Post-doc studies especially open doors to further research careers, change career directions, pursue a passion for a particular subject, enter a profession that needs a specific qualification, gain a clear insight into industry, or create invaluable contacts[55]. Another advantage of of postgraduate study is that it allows the researcher to continue his/her career while adding additional skills and knowledge. During the interviews, the İTÜ representative stated, “Researchers who performed studies in EU countries enter more easily into EU networks”, which implies

[55] Findings adapted from “The Postgraduate Taught Experience Survey 2011”, accessed at http://www.prospects.ac.uk/postgraduate_study_why_do_postgraduate_study.htm on 22 August 2013.

a networking effect and cognitive proximity with the EU agenda. Additionally, the Koç University representative stated that: “Broadening the spectrum of research is important. In addition to the main field of activity, additional areas of specialisation provide ability to manage EU-level projects with different people from several areas”. He added that if they found such researchers, they would recruit them without looking at their research areas. Therefore, researchers should look for ways to broaden their research areas. Considering the general research environment in emerging economies, it seems that the most pragmatic way to do so is to conduct a post-doc study abroad.

6.3.2 Enhance the Engagement with Industry

Many researchers lack an understanding of the relevance of their studies at the industry level. It is believed that within the economic conditions of a country like Turkey it is important to uncover industry-related opportunities for collaboration. The quantitative part of this research clearly shows that gatekeepers engage closely with industry, as well. Sabancı University’s representative highlighted the significance of strategic initiatives, especially with the private sector’s R&D centres. Similarly, METU shared experiences on guiding senior researchers to set up links with the technopark firms at METUTECH. Our analysis also stressed that most collaborative arrangements are on an ad-hoc basis or initiated at the researcher level. Moreover, in one-to-one discussions with the area experts, it was stated that in some specific cases hub organisations choose partners from the periphery who own or have the ability to reach local knowledge. Therefore, for researchers in ICT, it seems crucial to establish and maintain close relations with industry, which may provide future opportunities and open new doors.

6.3.3 Contribute to Consultation Processes of TÜBİTAK and the European Commission

Wide consultation processes with partners across the higher education and research sectors is a trendy topic among policy-makers of OECD countries and was clearly highlighted in the OECD Innovation Strategy report[56]. Consultative governance mechanisms are promoted in Turkey, as well. The sector-oriented standpoint adopted within the National Science, Technology, and Innovation Strategy (UBTYS) has been promoted by two result-driven and targeted call-based funding programmes designed by TÜBİTAK recently. Accordingly, temporary governance mechanisms have been established by TÜBİTAK in priority areas, which allows an environment for a bottom-up and entrepreneurial discovery of the technology needs of each sector. These governance mechanisms comprised high-level representatives from academia, the private sector, and the public sector. In the high-level prioritisation meetings of these actors, a consultative and consensus-building process takes place to designate R&D priorities in each sector. Calls are opened in each sector through the ongoing TÜBİTAK funding mechanisms in technology needs and/or topics that have been previously identified and prioritised at such high-level prioritisation meetings. Adopting roles in these processes provides access to novel policy tools and data sources, as well as occasion to be recognised by the public authorities.

6.3.4 Identify EU-Level Partners

Based on the findings published in the ICT Technology Audit Study for Turkey[57], it can be stated that the low levels of participation by Turkish organisations in official and non-official EU networks is the most crucial, since much of the participation in submitted projects resulted in unsatisfactory performance[58]. It should be noted that 67% of gatekeepers and 60% of the researchers in the three groups excluding inactive researchers received their PhDs from US institutions, which makes it

[56]http://www.oecd.org/sti/45302349.pdf, accessed on 22 August 2013.
[57]http://stps.metu.edu.tr/sites/stps.metu.edu.tr/files/task9.pdf, accessed on 22 August 2013.

somewhat harder for them to be visible at EU levels at initial stages. This requires further effort in engagement and networking at the EU level and proactive approaches to get EU funding.

6.3.5 Invest in Soft Skills

During the interviews, the Bilkent University representative stated that “the number of researchers who can lead big international projects does not exceed the fingers of one hand”, stressing the importance of not only scientific background but also the soft skills required.

Listed as hard-working attitude, public speaking skills, ability to manage personal relationships, ability to work independently, ability to work in teams, creative skills and ability to formulate new problems and ideas, and ability to accept and learn from criticism[59], in other words, all types of soft skills are crucial in in all areas of academic career such as teaching, presenting, and the writing of funding applications. The soft-skills issue is handled in the policy-making sphere, as well. For example, a study on “Employer Demand for Researchers in Australia” presents the ‘T skills’ concept to describe the combination of skills a researcher requires for the future – deep, narrow, and discipline-focused skills and broad soft or life skills[60]. EUREA, an independent organisation from Slovakia, conducted a project that similarly highlights the soft skills of young physicists[61].

It is assumed that transferable skills (i.e. soft-skills) are gathered throughout the research career, but developing them further is important. In international project work it is also essential to spend time developing

[59] This list was gathered from blog discussions at http://academia.stackexchange.com/questions/1799/which-soft-skills-for-research-career, accessed on 22 August 2013.
[60] Allen Consulting Group (2010), Employer Demand for Researchers in Australia, Report to the Department of Innovation, Industry, Science and Research
[61] http://www.eurea.sk/en/veda-a-vzdelavanie/vedecke-a-vzdelavacie-projekty/, accessed on 22 August 2013.

personal relationships with project partners. “It is also important to have ability to read the unspoken and unwritten language of cultural norms of other countries. Once the motivating forces of international partners are understood, potential frustrations can be avoided and replaced with strategies for success”[62]. At the research level it may be fruitful to participate in workshops and seminar programmes on soft skills and leadership skills. It seems easy to gather them, but developing soft-skills should also not be neglected.

[62] Gathered from the article entitled “The Soft Skills of International Project Management”, which was based on personal observations of Jay Grinstead, accessed from http://www.nasa.gov/offices/oce/appel/ask/issues/49/49s_soft_skills_ipm.html on 22 August 2013.

CHAPTER VII

CONCLUSION AND FURTHER RESEARCH

7.1 Concluding Remarks

This thesis examines whether ICT researchers engaged in international collaboration have significant local activity at the national level. Considering the landscape for R&D, Turkey has achieved a remarkable momentum in key S&T measures, including total R&D expenditures, higher education R&D expenditures, number of FTE researchers, number of scientific publications, and number of PCT patent fillings, although diminished growth rates are observed for 2007–2011, which is the second period of the present analysis. In line with the increase in governmental funding for academic research, the demand and the supply for ICT projects have also been increased. Concerning international collaboration in ICT, 10-year data analysis says that Turkey is facing challenges in levering bilateral and multilateral collaboration as well as FP7 ICT programmes. Except for six universities, international collaboration of universities is very low, which is 16% of TÜBİTAK's total academic R&D funding where only 33 universities were engaged in ICT collaboration between 2003 and 2013.

Under these circumstances, this thesis is focused on Turkish researchers who are engaged in international collaboration. To conduct tests on their local focus, first we needed to characterise profiles of ICT researchers in terms of their degree of globalisation versus localisation, and so their global and local project portfolios were mapped against each other for two periods of time. Global and local performance of the population was traced with respect to five indicators, which are international and national project densities, publication output, involvement in decision making processes on

academic project funding, and contribution to R&D capacity development in the private sector. We see that the results are situational. There is a group of researchers who are extremely successful at both levels, which means that they create local buzz. On the other hand, there are two additional groups that have only a one-dimensional focus for a given time interval, either local or global. The last group consists of more or less inactive researchers who did not show significant scientific performance above the average for either of the two dimensions.

Following the setting up of the framework for mapping international and national dynamics of an ICT researcher in Turkey, we have also found that better performance at both levels has a relationship with overseas work experience after PhD fulfilment and the research landscape provided by the university with which the researcher is now affiliated. Such types of limited findings implied that further analysis should be conducted to unlock the dynamics of ICT research in Turkey. Based on that, objective in-depth interviews were conducted with high-level representatives of the six most successful universities in ICT in Turkey. In-depth interviews clearly highlighted the needs for differentiated policy tools in terms of the different researchers' profiles, as well as internationalisation strategies at the university level. Both actions seem crucial, because the Turkish ICT landscape is not connected internationally except these six universities. Moreover, other policy recommendations were dedicated in a special chapter organised in three dimensions: macro, meso, and micro.

7.2 Further Research

This study presents the Turkish case and offers taxonomy for assessing local–global collaboration dynamics at the researcher level. It would be fruitful to test the taxonomy in BRICS and EU12 countries and also to build a ground for performing country level comparisons.

Similar grounds can be deployed for different sectors in Turkish research and innovation ecosystems. The performing of similar studies in other priority areas listed in the National Science, Technology, and Innovation Strategy, namely UBTYS 2011-2016, is suggested.

Further examination about origins and determinants explaining the differences in research portfolios of researchers with similar backgrounds could contribute to development of more evidence-based policies.

In line with the argument stated above, further analysis to explore the impact of local–global links bridged by the best-performing researchers will be helpful for further testing of evidence-based policies.

Noting that most of the Turkish ICT researchers in this study's population have received their PhD degrees from US universities, it would be interesting to perform a similar study to explore dynamics of US–Turkey collaboration linkages.

REFERENCES

Aho, E., Cornu, J., Georghiou, L., & Subira, A. (2006). Creating an innovative Europe. *Report of the Independent Expert Group on R&D and Innovation appointed following the Hampton Court Summit*.

Akçomak, S., Akdeve, E., & Fındık, D. (2013). *How do ICT firms in Turkey manage innovation? Diversity in expertise versus diversity in markets* (No. 1301). STPS-Science and Technology Policy Studies Center, Middle East Technical University.

Anand, B. N., & Khanna, T. (2000). Do firms learn to create value? The case of alliances. *Strategic management journal*, *21*(3), 295-315.

Apilo, T. (2004, September). Management of networked R&D processes. In *Proceeding of the 5th International CINet Conference* (pp. 22-25).

Archibugi, D., & Lundvall, B. Å. (2002). *The globalizing learning economy*. Oxford University Press.

Armatli-Köroğlu, B. (2004). *SME networks as new engines of economic development and innovativeness* (Doctoral dissertation, Middle East Technical University).

Barabási, A. L., & Frangos, J. (2002). *Linked: The New Science of Networks*. Basic Books.

Barabási, A. L., & Albert, R. (1999). Emergence of scaling in random networks.*science*, *286*(5439), 509-512.

Barber, M. J., Paier, M., & Scherngell, T. (2009). Analyzing and modeling European R&D collaborations: Challenges and opportunities from a large social network. *Analysis of Complex Networks*, 232.

Barnard, H., Cowan, R., & Müller, M. (2012). Global excellence at the expense of local diffusion, or a bridge between two worlds? Research in science and technology in the developing world. *Research Policy*, *41*(4), 756-769.

Bathelt, H., Malmberg, A., & Maskell, P. (2004). Clusters and knowledge: local buzz, global pipelines and the process of knowledge creation. *Progress in human geography*, *28*(1), 31-56.

Bathelt, H. (2007). Buzz-and-Pipeline Dynamics: Towards a Knowledge-Based Multiplier Model of Clusters. *Geography Compass*, *1*(6), 1282-1298.

Bayona, C., Garcıa-Marco, T., & Huerta, E. (2001). Firms' motivations for cooperative R&D: an empirical analysis of Spanish firms. *Research Policy*, *30*(8), 1289-1307.

Becic, E. (2011). Production process of quality STI statistics harmonized with Frascati and Oslo standards, *SEA-EU-NET STI Indicators Workshop*. Chiang Mai, Thailand.

Benneworth, P., & Dassen, A. (2011). *Strengthening global-local connectivity in regional innovation strategies: implications for regional innovation policy* (No. 2011/1). OECD Publishing.

Borgatti, S. P., & Foster, P. C. (2003). The network paradigm in organizational research: A review and typology. *Journal of management*, *29*(6), 991-1013.

Breschi, S., & Cusmano, L. (2004). Unveiling the texture of a European Research Area: emergence of oligarchic networks under EU Framework Programmes. *International Journal of Technology Management*, *27*(8), 747-772.

Cabo, P. G. (1999). Industrial participation and knowledge transfer in joint R&D projects. *International Journal of Technology Management*, *18*(3), 188-206.

Caloghirou, Y., Vonortas, N. S., & Ioannides, S. (2002). Science and technology policies towards research joint ventures. *Science and Public Policy*,*29*(2), 82-94.

Caloghirou, Y., Hondroyiannis, G., & Vonortas, N. S. (2003). The performance of research partnerships. *Managerial and Decision Economics*, *24*(2-3), 85-99.

Caracostas, P., & Muldur, U. (1998). Society, the endless frontier (No. EUR-17655). Euratom.

Castellani, D., Zanfei, A., & Muendler, M. A. (2006). *Multinational firms, innovation and productivity*. Cheltenham: Edward Elgar.

Castells, M. (2011). *The rise of the network society: The information age: Economy, society, and culture* (Vol. 1). Wiley. com.

Christopherson, S., Garretsen, H., & Martin, R. (2008). The world is not flat: putting globalization in its place. *Cambridge Journal of Regions, Economy and Society*, *1*(3), 343-349.

Cohen, W. M., & Levinthal, D. A. (1990). Absorptive capacity: a new perspective on learning and innovation. *Administrative science quarterly*, 128-152.

Cooke, P., Gomez Uranga, M., & Etxebarria, G. (1997). Regional innovation systems: Institutional and organisational dimensions. *Research policy*, *26*(4), 475-491.

Corder, G. W., & Foreman, D. I. (2009). Nonparametric Statistics for Non-Statisticians: A Step-by-Step Approach Wiley: Hoboken.

David, P. A., & Foray, D. (2002). An introduction to the economy of the knowledge society. *International social science journal*, *54*(171), 9-23.

DeBresson, C., & Amesse, F. (1991). Networks of innovators: a review and introduction to the issue. *Research policy*, 20(5), 363-379.

Dubois, A., Copus, A., & Hedström, M. (2012). Local embeddedness and global links in rural areas: Euclidean and Relational Space in Business Networks. In *Translocal Ruralism* (pp. 103-121). Springer Netherlands.

Dumont, M., & Tsakanikas, A. (2002). The evolution of intra-and inter-sector knowledge spillovers in the EU Framework Programmes. *CESIT-paper2002/01*.

Dyer, J., & Nobeoka, K. (2002). Creating and managing a high performance knowledge-sharing network: the Toyota case.

Eisenhardt, K. M. (1989). Building theories from case study research. *Academy of management review*, *14*(4), 532-550.

Erdil, E., & Çetin, D. (2008). *Innovation and relationships in an organized industrial district: Ankara Sincan Industrial District* (No. 0802). STPS-Science and Technology Policy Studies Center, Middle East Technical University.

Erdil, E., Durgut, M., Pamukcu, T., Ozman, M., & Goksidan, H. T. (2008). Kümeler, Sanayi Ağlari ve Inovasyon: Ankara Bölgesi Makina ve Mobilya Sektörleri Örnegi Projesi Sonuç Raporu. Ankara.

Erkan E., Geray H., Turkeli S., Goksidan H.T., Eren Y. G. (2011). *ICT RTD Technological Audit Project-Turkey.* Brussels: European Commission

Eriksson, S. (2006). Cluster creation and innovation within an emerging Taiwanese high-tech sector. *International journal of technology transfer and commercialisation*, *5*(3), 208-236.

Etzkowitz, H., & Leydesdorff, L. (2000). The dynamics of innovation: from National Systems and “Mode 2” to a Triple Helix of university–industry–government relations. *Research policy*, *29*(2), 109-123.

European Commission. (2000). *Towards a European Reseach Area. Commission of The European Communities*.

European Commission (2005). *Proposal for a Council Decision concerning the Seventh Framework Programme*.

European Commission (2008*), Evaluating the effectiveness of European ICT RTD and Innovation Systems*. Retrieved from http://ec.europa.eu/dgs/information_society/evaluation/data/pdf/studies/network_studies_overview_compilation.pdf on 30 September 2013.

European Council. (2006). *Time to move up a gear: The new partnership for growth and jobs.* Office for Official Publications of the European Communities.

Florida, R. (2005). The World is Spiky Globalization has changed the economic playing field, but hasn't leveled it. *Atlantic Monthly*, *296*(3), 48.

Foster, H.. and and Jones, I. (2011), Mobilizing your institutional Strategic international partnerships" in Buck S. and Obst D. (eds) "Developing Strategic International Partnerships – Models for initiating and sustaining innovative institutional linkages", IIE Center for International Partnerships in Higher Education

Foster, P., Borgatti, S. P., & Jones, C. (2011). Gatekeeper search and selection strategies: Relational and network governance in a cultural market.*Poetics*, *39*(4), 247-265.

Freeman, C. (1991). Networks of innovators: a synthesis of research issues.*Research policy*, *20*(5), 499-514.

Freeman, C. (1995). The 'National System of Innovation'in historical perspective. *Cambridge Journal of economics*, *19*(1), 5-24.

Freeman, C., & Soete, L. (2009). Developing science, technology and innovation indicators: What we can learn from the past. *Research Policy*, *38*(4), 583-589.

Freeman, R. (2005). Does globalization of the scientific/workforce threaten US economic leadership? NBER Innovation Policy and Economy Economy, (June).

Friedman, T. L. (2006). *The world is flat [updated and expanded]: A brief history of the twenty-first century*. Macmillan.

Georghiou, L. (1998). Global cooperation in research. *Research Policy*, *27*(6), 611-626.

Georghiou, L. (2001). Evolving frameworks for European collaboration in research and technology. *Research Policy*, *30*(6), 891-903.

Gertler, M. S., & Levitte, Y. M. (2005). Local nodes in global networks: the geography of knowledge flows in biotechnology innovation. *Industry and Innovation*, *12*(4), 487-507.

Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, S., Scott, P., & Trow, M. (1994). *The new production of knowledge: The dynamics of science and research in contemporary societies*. Sage.

Gillham, B. (2000). The Research Interview. New York: Continuum.

Glaser, B. G., & Strauss, A. L. (2009). *The discovery of grounded theory: Strategies for qualitative research*. Transaction Books.

Godelier, M. and Duncan G.(2005). SSHERA Project Mission Report Turkey." Retrieved from http://ec.europa.eu/research/social-sciences/pdf/mission_report2_turkey_en.pdf on 30 September 2013

Gould, R. V., & Fernandez, R. M. (1989). Structures of mediation: A formal approach to brokerage in transaction networks. *Sociological methodology*, 89-126.

Grabher, G., & Ibert, O. (2013). Distance as asset? Knowledge collaboration in hybrid virtual communities. *Journal of Economic Geography*.

Graf, H., & Krüger, J. J. (2009). *The performance of gatekeepers in innovator networks* (No. 2009, 058). Jena economic research papers.

Graf, H. (2011). Gatekeepers in regional networks of innovators. *Cambridge Journal of Economics*, *35*(1), 173-198.

Griliches, Z. (1992). *The search for R&D spillovers* (No. w3768). National Bureau of Economic Research.

Guler, H., & Kara, O. (2011). Enhancing Knowledge Spillovers Through International R&D Networking: The Case of Turkey's Participation in the 6th EU Framework Programme.

Görtz, R. von. (2005). Governance of Research Networks. foev-speyer.de, 1–6. Retrieved from http://www.foev-speyer.de/governance1/projektbilder/Dateien/Goertz_Expose Diss english_Governance of Research Networks.pdf

Hagedoorn, J. (2002). Inter-firm R&D partnerships: an overview of major trends and patterns since 1960. *Research policy*, *31*(4), 477-492.

Hagedoorn, J., & Duysters, G. (2002). Learning in dynamic inter-firm networks: the efficacy of multiple contacts. *Organization studies*, *23*(4), 525-548.

Hagedoorn, J., & van Kranenburg, H. (2003). Growth patterns in R&D partnerships: an exploratory statistical study. *International Journal of Industrial Organization*, *21*(4), 517-531.

Moon, H. S., & Lee, J. D. (2005). A fuzzy set theory approach to national composite S&T indices. *Scientometrics*, *64*(1), 67-83.

Kastelli, I. (2006). The Determinants of Organisational Knowledge Creation in the Context of R&D Cooperation.

Kuppers, G., & Pyka, A. (2002). The self-organisation of innovation networks: introductory remarks. *Innovation Networks: Theory and Practice*, 3-21.

Lall, S. (2001). *Competitiveness, Technology and Skills*. Edward Elgar Publishing Inc., 2 Winter Sport Lane, PO Box 574, Williston, VT 05495-0080.

Laranja, M., & Boavida, N. (2012). The use of indicators and evidence in governance and policy development of Science, Technology and Innovation.

Laudel, G. (2002). What do we measure by co-authorships?. *Research Evaluation*, *11*(1), 3-15.

Lohr, S. L. (2010). *Sampling: design and analysis*. Cengage Learning.

Malerba, F., Vonortas, N., Breschi, S., & Cassi, L. (2006). Evaluation of progress towards a European Research Area for information society technologies. *Report to European Commission, DG Information Society and Media*.

Malerba, F., Vonortas, N., Cassi, L., Corrocher, N., & Wagner, C. (2007). Networks of Innovation in Information Society: Development and Deployment in Europe. *Final Report Draft, Milano: CESPRI–Bocconi University*.

Malmberg, A., & Maskell, P. (2006). Localized learning revisited. *Growth and Change*, *37*(1), 1-18.

Marin, A., & Bell, M. (2006). Technology spillovers from Foreign Direct Investment (FDI): the active role of MNC subsidiaries in Argentina in the 1990s.*The Journal of Development Studies*, *42*(4), 678-697.

Maskell, P., Bathelt, H., & Malmberg, A. (2006). Building global knowledge pipelines: the role of temporary clusters. *European Planning Studies*, *14*(8), 997-1013.

McCann, P. (2008). Globalization and economic geography: the world is curved, not flat. *Cambridge Journal of Regions, Economy and Society*, *1*(3), 351-370.

Miotti, L., & Sachwald, F. (2003). Co-operative R&D: why and with whom?: An integrated framework of analysis. *Research Policy*, *32*(8), 1481-1499.

Mohr, J. J., & Sengupta, S. (2002). Managing the paradox of inter-firm learning: the role of governance mechanisms. *Journal of Business & Industrial Marketing*, *17*(4), 282-301.

Moodysson, J. (2008). Principles and practices of knowledge creation: On the organization of “buzz” and “pipelines” in life science communities. *Economic Geography*, *84*(4), 449-469.

Narula, R., & Dunning, J. H. (2000). Industrial development, globalization and multinational enterprises: new realities for developing countries. *Oxford development studies*, *28*(2), 141-167.

Nelson Richard, R., & Winter Sidney, G. (1982). An evolutionary theory of economic change. *Harvard Business School Press, Cambridge*.

Newman, M. E. (2003). The structure and function of complex networks. *SIAM review*, *45*(2), 167-256.

Nokkala, T., Heller-Schuh, B., & Paier, M. (2011). Ranking lists and European Framework Programmes: Does university status matter for performance in Framework Programmes?. *Public Vices, Private Virtues? Assessing the Effects of Marketization in Higher education/P. Teixeira & D. Dill (eds.)*.

Nokkala, T. (2007). Network building, motivation and learning in inter-organisational R&D collaboration projects-Theoretical considerations.

Nokkala, T. (2009). *Internal collaboration rules in international R&D collaboration projects-Analysis of seven NEST projects* (Vol. 15). NEMO Working Paper.

Nokkala, T., Heller-Schuh, B., Paier, M., & Wagner-Luptacik, P. (2008, October). Internal integration and collaboration in European R&D projects. In *1st ICC Conference on Network Modelling and Economic Systems. Lisbon, Portugal*.

Oliver, C. (1990). Determinants of interorganizational relationships: Integration and future directions. *Academy of management review*, *15*(2), 241-265.

Ortega, J. L., & Aguillo, I. F. (2010). Shaping the European research collaboration in the 6th Framework Programme health thematic area through network analysis. *Scientometrics*, *85*(1), 377-386.

Ozman, M. (2009). Inter-firm networks and innovation: a survey of literature.*Economic of Innovation and New Technology*, *18*(1), 39-67.

Ozman, M. (2010). The Joint Effect of Technological Distance and Market Distance on Strategic Alliances. *Available at SSRN 1612767*.

Polt, W., Vonortas, N., Papaconstantinou, G., & Puissochet, A. (2006). IST Evaluation and Monitoring. *Final Report, European Commission, DG Information Society and Media*.

Pérez-Castrillo, J. D., & Sandonis, J. (1997). Disclosure of know-how in research joint ventures. *International Journal of Industrial Organization*, *15*(1), 51-75.

Peterson, J. (1991). Technology Policy in Europe: Explaining the Framework Programme and Eureka in Theory and Practice*. *JCMS: Journal of Common Market Studies*, *29*(3), 269-290.

Porter, M. E. (1993). *The competitive advantage of nations* (pp. 73-93). Harvard Business School Management Programs.

Powell, W. W., Koput, K. W., & Smith-Doerr, L. (1996). Interorganizational collaboration and the locus of innovation: Networks of learning in biotechnology.*Administrative science quarterly*, 116-145.

Powell, W. W., & Grodal, S. (2005). Networks of innovators. *The Oxford handbook of innovation*, 56-85.

Protogerou, A., Caloghirou, Y., & Siokas, E. (2007). The structure of EU funded R&D collaboration networks in the area of information society technologies. 47th Congress of the European Regional Science Association (pp. 1–32).

Rodan, S., & Galunic, C. (2004). More than network structure: how knowledge heterogeneity influences managerial performance and innovativeness. *Strategic Management Journal*, *25*(6), 541-562.

Roediger-Schluga, T., & Barber, M. J. (2006). *The structure of R&D collaboration networks in the European Framework Programmes* (p. 36). UNU-MERIT.

Roediger-Schluga, T., & Barber, M. J. (2008). R&D collaboration networks in the European Framework Programmes: Data processing, network construction and selected results. *International Journal of Foresight and Innovation Policy*,*4*(3), 321-347.

Roediger-Schluga, T., & Dachs, B. (2006). *Does technology affect network structure?-A quantitative analysis of collaborative research projects in two specific EU programmes* (No. 041). United Nations University, Maastricht Economic and social Research and training centre on Innovation and Technology.

Rosenberg, N. (1982). *Inside the black box: technology and economics*. Cambridge University Press.

Schibany, A., & Polt, W. (2001). Innovation and networks: an introduction to the theme. *Innovative networks. co-operation in national innovation systems*, 7-13.

Singh, N. P. (2009). 27 Development Leadership in a Knowledge Economy. *Knowledge economy: the Indian challenge*, 242.

Todtling, F., & Trippl, M. (2007). Knowledge links in high-technology industries: Markets, Networks or Milieu? The case of the Vienna biotechnology cluster.*International Journal of Entrepreneurship and Innovation Management*, *7*(2), 345-365.

Trippl, M., F. Todling & L. Lengauer (2009), Knowledge Sourcing Beyond Buzz and Pipelines: Evidence from the Vienna Software Sector. Economic Geography, 85:443-462

Tsai, W. (2001). Knowledge transfer in intraorganizational networks: Effects of network position and absorptive capacity on business unit innovation and performance. *Academy of management journal*, *44*(5), 996-1004.

UNCTAD. (2005). United Nations conference on trade and development globalization of R&D. New York.

Wagner, C. S., Brahmakulam, I., Jackson, B., Wong, A., & Yoda, T. (2001). *Science and Technology Collaboration: Building Capability in Developing Countries* (No. RAND/MR-1357.0-WB). RAND CORP SANTA MONICA CA.

Wagner, C. S, Cave, J., Leydesdorff, L., Allee, V., Graafland, I., Perez, R., & Botterman, M. (2004). ERAnets Evaluation of Networks of Collaboration Between Participants in IST Research and Their Evolution to Collaborations in The European Research Area (ERA). *Inception Report, Directorate-Generale Information Society and Media*

Wagner, C. S., Cave, J., Tesch, T., Allee, V., Thompson, R., Leydesdorff, L., & Botterman, M. (2005). ERAnets: Evaluation of NETworks of Collaboration among Participants in IST Research and their Evolution to Collaborations in the European Research Area (ERA). *Final Report, Directorate-Generale Information Society and Media*

Wagner, C. S., & Leydesdorff, L. (2005). Network structure, self-organization, and the growth of international collaboration in science. *Research policy*,*34*(10), 1608-1618.

Wagner, C. S. (2005). The Globalization of Research : Understanding the Dynamics of Collaborative Research Networks. The Conference on International Collaboration in Social Sciences Research.

Wagner, C. S. (2006). International collaboration in science and technology: Promises and pitfalls. *Science and technology policy for development, dialogues at the interface*.

Wagner, C. S., & Leydesdorff, L. (2005). Network structure, self-organization, and the growth of international collaboration in science. *Research policy*, *34*(10), 1608-1618.

Wagner, C. S. and L. Leydesdorff (2006). Measuring the Globalization of Knowledge Networks. Blue Sky. Manuscript submitted in September 2006: 12.

Whetten DA., Developing “Good” Theory Through Articulation and Examination Brigham Young University Summer, 2000

Yin, R.K. (1994) Case study research Design and Methods. 2nd edition, Sage publication. Thousand Oaks.

Zahra, S. A., & George, G. (2002). Absorptive capacity: A review, reconceptualization, and extension. *Academy of management review*, *27*(2), 185-203.

APPENDICES

APPENDIX A: EU27, EU15, AND EU15 COMPARISONS OF TURKEY'S FP6 IST AND FP7 ICT DATA

According to the FP6 IST data provided by the European Commission, for retained projects around 3,5 billion Euros were allocated to a group of countries including EU27 and Turkey. The breakdown of that budget is as follows: EU15: 90%, EU12: 10%, Turkey: 0.3%. If the performance of Turkey is compared with the EU15 and EU12, it is seen that Turkey's level is about 0,4% of the EU 15 and 3% of the EU12.

In order to achieve a more concrete comparison, the data for FP6 IST were normalised with FTE researchers and national R&D expenditure per FTE researcher (Figure 10).

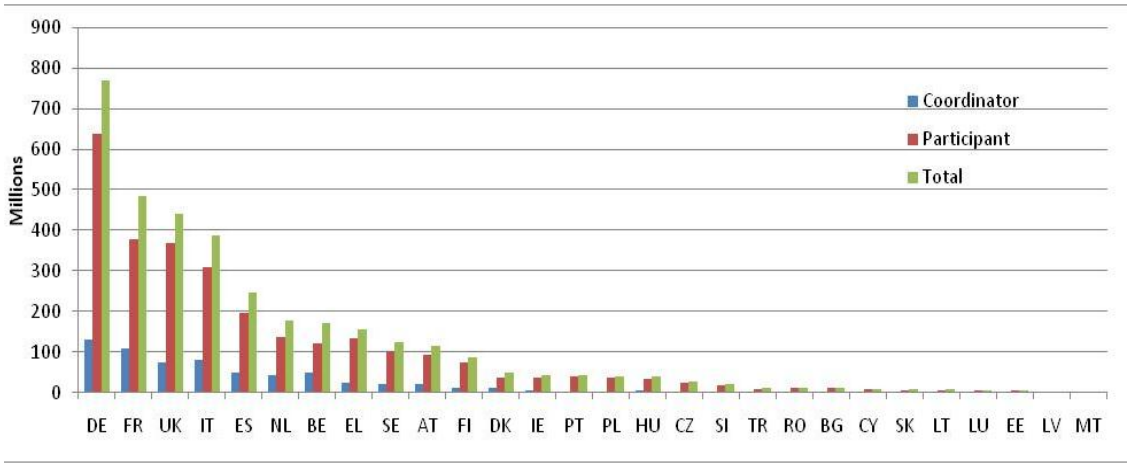


Figure 10: Participation of the EU 27 and Turkey in FP6 IST (2003–2006), breakdown based on funds received from the European Commission.

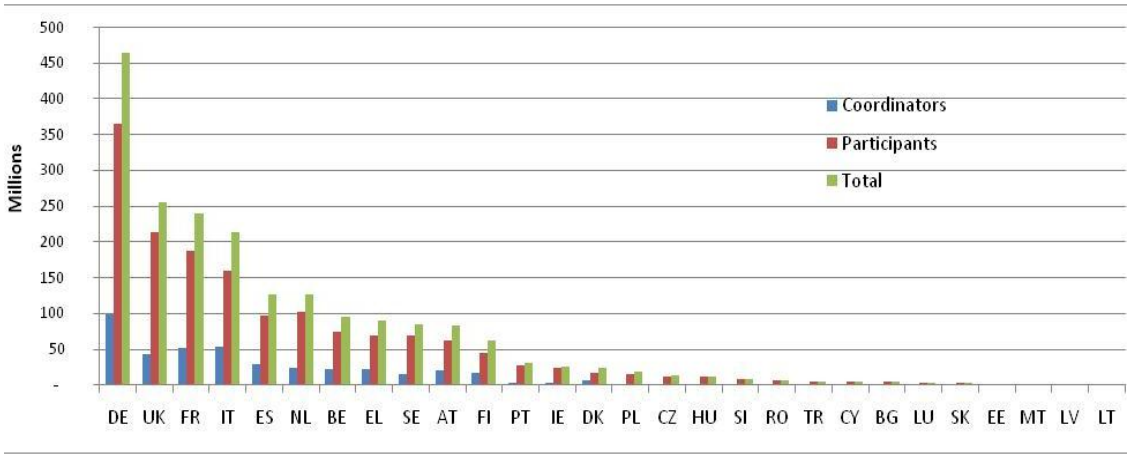


Figure 11: EU 27 and Turkey in FP7 ICT (2007–2008), breakdown based on funds received from the European Commission.

Similar analysis for FP7 ICT shows that 2.0 billion Euros were allocated by the European Commission to the EU27 and Turkey for retained projects when the first three calls of ICT, FET, and the Joint ICT–Security Call are considered. The breakdown of this budget is as follows: EU 15: 96%, EU 12: 3,7%, Turkey: 0,3%. If the performance of Turkey is compared with the EU 15, Turkey's level decreased from 0,4% to 0,3%. On the other hand, comparison with the EU 12 indicates that Turkey's level increased from 4% to 7%. This is because the EU 12's share decreased from 10% to 4% when fund allocation breakdown of FP IST and FP7 ICT is taken into consideration. The overall results illustrate that the EU 15 countries increased their share in the FP7 ICT theme compared to FP6 IST. To conduct the analysis researchers' data for 2003 from Eurostat were used. Similarly, to normalise the FP7 results, 2007 data for FTE researchers from the same source were utilised.

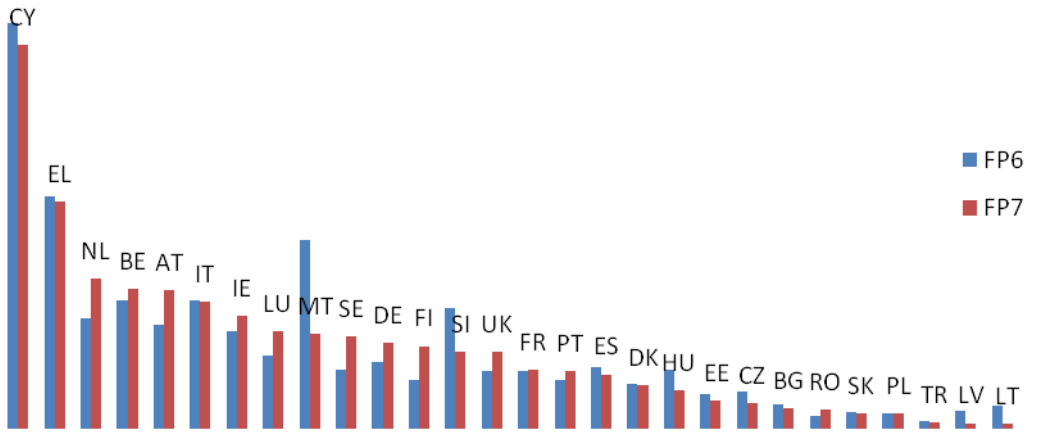


Figure 12: The EU 27 and Turkey, breakdown based on funds per FTE researcher

The ranking list based on the IST/ICT funds per FTE researcher shows that Turkey's situation is not satisfactory, although the country advanced by two ranks from FP6 to FP7. Since the timeframe of data for FP6 and FP7 in this analysis is not same (four-year data for FP6 and two-year data for FP7), the values were normalised in order to make a comparison[63]. Based on the normalisation, it can be stated that while in FP6 IST Turkey's level was around 10% of the average IST funding per EU 27 FTE researcher, in FP7 this rate decreased to 7%.

[63] In order to overcome this problem, average values for fund per FTE researcher for the EU 27 and Turkey were found for FP6 IST and FP7 ICT, respectively. Then, for each FP, the granted Euros per FTE researcher in each EU 27 country and Turkey was divided into the respective average (FP6 IST average or FP7 ICT average for EU 27 plus Turkey). To facilitate better visualisation in the figures, each ratio was multiplied by 100, and, finally, the ranking list was elaborated.

Figure 13: The EU 15 and Turkey, breakdown based on funds per FTE researcher

If similar analysis is done for Turkey and the EU 15, it can be stated that the average IST funding per FTE researcher in Turkey is around 9% of the average IST funding per FTE researcher in the EU 15. This rate decreases to 7% in the FP7. Here, it is also noteworthy that the similar rate for the EU 12 with respect to the EU 15 decreases from 90% to 59%.

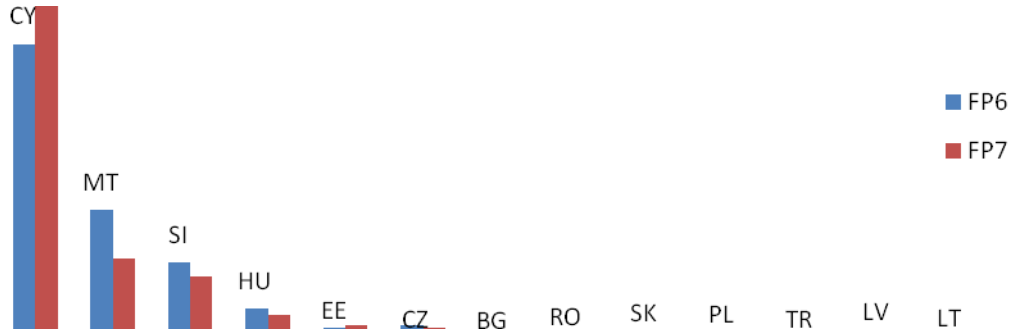


Figure 14: The EU 12 and Turkey, breakdown based on funds per FTE researcher

With a similar approach, the breakdown based on funds per FTE researcher for the EU 12 and Turkey illustrates that, except for Cyprus, Malta and Slovenia, the rate is lower than in EU 15 countries. In both the FP6 and FP7, the funding per FTE researcher in Turkey is around 10% of that in the

EU 12 countries. In order to compile the analyses for Figure 12, Figure 13 and Figure 15 and to normalise the FP6 results, data on FTE researchers and R&D expenditures for 2003 from Eurostat were used. Similarly, to normalise the FP7 results, 2007 data on FTE researchers and R&D expenditures from the same source were employed.

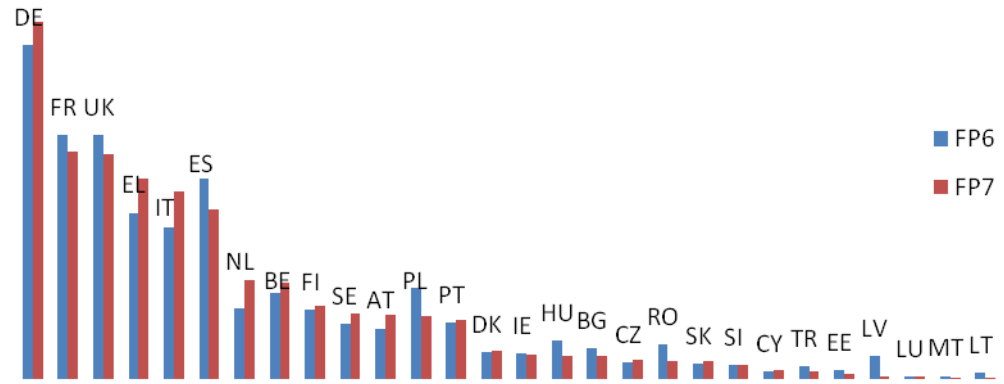


Figure 15: The EU 27 and Turkey, breakdown based on EC funds normalised with national R&D expenditure per FTE researcher

Another analysis was done based on the data normalised with the national R&D expenditure per FTE researcher (Figure 16 and Figure 17). The ranking list in Figure 17 demonstrates that Turkey lies among the five countries at the bottom of the list.

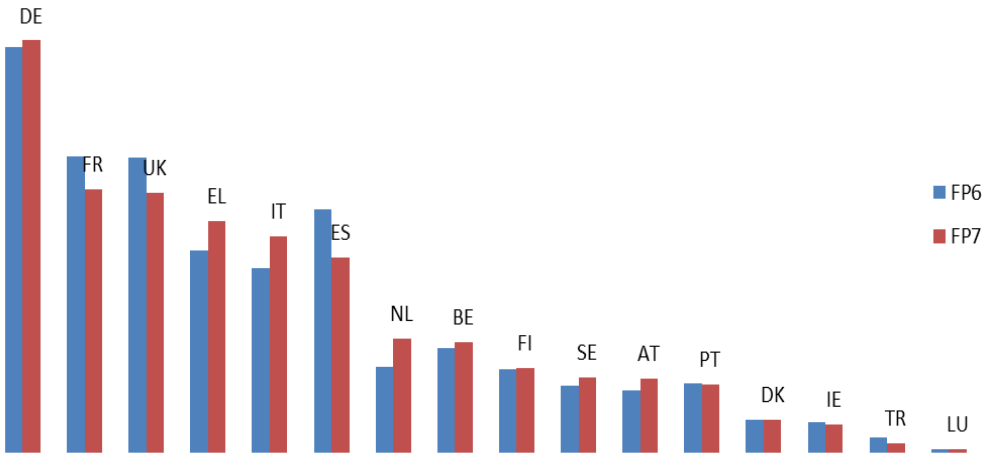


Figure 16: The EU 15 and Turkey, breakdown based on EC funds normalised with national R&D expenditure per FTE researcher

Applying the same normalisation approach, it can be stated that the EU 15 countries succeeded in increasing more rapidly in their share of EU funds per national R&D expenditure for one FTE researcher than Turkey did.

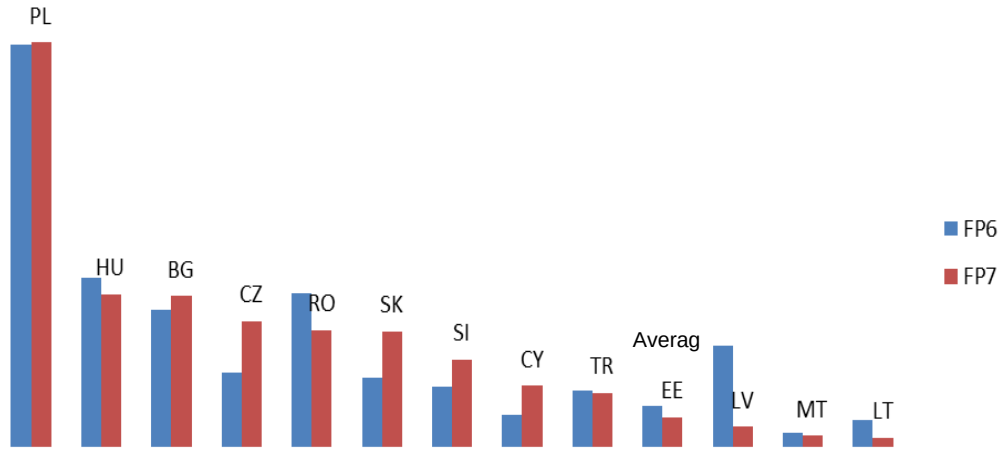


Figure 17: The EU 12 and Turkey, breakdown based on EC funds normalised with national R&D expenditure per FTE researcher.

APPENDIX B: INDEX FOR MEASURING DEGREE OF LOCAL BUZZ AND GLOBAL PIPELINES AT RESEARCHER LEVEL

Dataset

Turkish involvement in the European Framework Programmes provides a sufficient set of data for analysing the international collaboration dynamics of Turkish organisations, with around 400 partnerships for the period of 2003–2006. Considering that the scope and objectives of the Programmes are very broad, this study focuses on one of the seven thematic priorities of FP6. Therefore, in the context of the thesis, the goal is to evaluate the positioning and dynamics of Turkish organisations in IST research networks funded under the FP6 umbrella and the local deployment patterns of knowledge gathered from those networks.

The IST field was chosen because it has been the priority of Europe-wide R&D programmes since the early 1980s and it draws the highest budget allocation of the European Commission. This area also attracted the most interest from Turkish researchers during the period of 2003–2006, which provides a more comprehensive dataset for conducting analysis of network dynamics. The availability of several EU IST evaluation studies was also helpful in developing a methodology to work on Turkish organisations in international collaboration networks and then to focus on their deployment patterns at the local level.

In order to deepen the analysis, it is necessary to clean up the dataset of Turkish organisations involved in FP6 IST projects. Initially, it was decided to focus only on IPs and STREPs, which are the two main instruments of FP6 for funding pure R&D projects. Alongside the STREPs and IPs, NoE consortia were formed; these were also included in the dataset because the sub-tasks of NoEs facilitate extensive learning and knowledge spillovers.

Based on those criteria, Turkish entities in funded IPs, NoEs and STREPs under the FP6 IST programme constituted the sample of the present thesis.

The scope of the study is bounded by collaborative projects funded by the European Commission between 2003 and 2006. However, since it traces the impact generated by FP6 IST projects, the time interval from the impact point of view covers the period from 2004 to 2012. Therefore, other research projects, including those funded by the Seventh Framework Programme, are also taken into consideration to model the knowledge gains of Turkish organisations that participated in FP6 IST.

Table 42: List of Turkish organisations participating in IP, STREPs and NoEs under FP6 IST

Name	Title	Instrument	City
METU	A **Semantic Web Service**-based P2P Infrastructure for the Interoperability of Medical Information Systems	STREP	ANKARA
METU	**Semantic-based** Interoperability Infrastructure for Integrating Web Service Platforms to Peer-to-Peer Networks	STREP	ANKARA
METU	**Multi-sensory Autonomous Cognitive Systems** Interacting with Dynamic Environments for Perceiving and Learning Affordances	STREP	ANKARA
METU	Intelligent **Healthcare** Monitoring Based on a **Semantic Interoperability Platform**	STREP	ANKARA
METU	**Application Bus for Interoperability** in Enlarged Europe SMEs	STREP	ANKARA
METU	Advanced **MEMS** For **RF** and **Millimeter Wave Communications**	NOE	ANKARA
METU	Intelligent Distributed **Cognitive-based Open Learning System** for Schools	IP	ANKARA
METU	Integrated **Three-Dimensional Television** - Capture, Transmission and Display	NOE	ANKARA

BILKENT UNIVERSITY	**Optical Networks**: Towards Bandwidth Manageability and Cost Efficiency	NOE	ANKARA
BILKENT UNIVERSITY	**Optical Networks**: Towards Bandwidth Manageability and Cost Efficiency (2nd Project)	NOE	ANKARA
BILKENT UNIVERSITY	Network of Excellence in **Wireless Communications**	NOE	ANKARA
BILKENT UNIVERSITY	**Multimedia** Understanding through **Semantics**, Computation and Learning	NOE	ANKARA
BILKENT UNIVERSITY	Integrated **Three-Dimensional Television** - Capture, Transmission and Display	NOE	ANKARA
BILKENT UNIVERSITY	**Nanophotonics** to Realize Molecular-Scale Technologies	NOE	ANKARA
KOÇ UNIVERSITY	Network of Excellence for **Micro-Optics**	NOE	ISTANBUL
KOÇ UNIVERSITY	The European Research Taskforce Creating **Human–Machine Interfaces** SIMILAR to Human–Human Communication	NOE	ISTANBUL
KOÇ UNIVERSITY	Integrated **Three-Dimensional Television** - Capture, Transmission and Display	NOE	ISTANBUL
KOÇ UNIVERSITY	**Nanophotonics** to Realize Molecular-Scale Technologies	NOE	ISTANBUL
SABANCI UNIVERSITY	Network of Excellence for **Micro-Optics**	NOE	ISTANBUL
SABANCI UNIVERSITY	Geographic Privacy-aware **Knowledge Discovery and Delivery**	STREP	ISTANBUL
SABANCI UNIVERSITY	Top **Amplifier Research Groups** in a European Team	NOE	ISTANBUL
TÜBİTAK UEKAE	**Open Trusted Computing**	IP	KOCAELI
TÜBİTAK UEKAE	An **Agent-based Software Platform** for European Economic Policy Design with Heterogeneous Interacting Agents: New	STREP	KOCAELI

	Insights from a Bottom Up Approach to Economic Modelling and Simulation		
TÜBİTAK UEKAE	Side Channel Analysis Resistant **Design Flow**	STREP	KOCAELI
BOĞAZIÇI UNIVERSITY	The European Research Taskforce Creating **Human–Machine Interfaces** SIMILAR to Human–Human Communication	NOE	ISTANBUL
BOĞAZIÇI UNIVERSITY	**Biometrics** for Secure Authentication	NOE	ISTANBUL
ISIK UNIVERSITY	Intercultural **Learning** Campus	STREP	ISTANBUL
ISIK UNIVERSITY	Network of Excellence in **Wireless Communications**	NOE	ISTANBUL
INTRO	**Semantic-based Interoperability** Infrastructure for Integrating Web Service Platforms to Peer-to-Peer Networks	STREP	ANKARA
INTRO	Integration of Geographical Information Systems with DB, **Decision-support Management** and an Auditory System to Develop an Advanced System that Will be Able to Give Support on Decisions in a Crisis	STREP	ANKARA
TEPE TECHNOLOGY	A **Semantic Web Service**-based P2P Infrastructure for the Interoperability of Medical Information Systems	STREP	ANKARA
TEPE TECHNOLOGY	Intelligent **Healthcare** Monitoring Based on a **Semantic** Interoperability Platform	STREP	ANKARA
BALKAN MAKINA	Collaborative **Virtual Engineering** for SMEs	STREP	AYDIN
BOYTAS	**Enterprise Application Interoperability** via Internet-Integration for SMEs, Governmental Organisations and Intermediaries in the New European Union	STREP	KAYSERI
CYBER SOFT	**Requirements-driven Software Development** System	STREP	ANKARA
EGE UNIVERSITY	Creating Ubiquitous Intelligent Sensing Environments [Network of Excellence on the Application and Communication Aspects of **Wireless Sensor Networking**]	NOE	IZMIR

IES	Intelligent Distributed **Cognitive-based Open Learning System** for Schools	IP	ANKARA
INNOVA	**Application Bus for Interoperability** in Enlarged Europe SMEs	STREP	ANKARA
KADIR HAS UNIVERSITY	Network of Excellence in **Wireless Communications**	NOE	ISTANBUL
LOGO	**Enterprise Application Interoperability** via Internet-Integration for SMEs, Governmental Organisations and Intermediaries in the New European Union	STREP	ISTANBUL
MIND2BIZ	Towards Integrating **Virtual Reality and Optimisation Techniques** in a New Generation of Networked Businesses in **Warehouse Management Systems** under Constraints	STREP	ISTANBUL
MOBILERA	Empowering the Mobile Worker by **Wearable Computing**	IP	ISTANBUL
MOMENTUM	Integrated **Three-Dimensional Television** - Capture, Transmission and Display	NOE	KOCAELI
PHONOCLICK	**OPENINTERFACE**	STREP	ISTANBUL
PORTAKAL	**Open Trusted Computing**	IP	ANKARA
RTB	Intelligent Distributed **Cognitive-based Open Learning System** for Schools	IP	ANKARA
SAKARYA UNIVERSITY	**Intelligent Robot Swarm** for Attendance, Recognition, Cleaning and Delivery	STREP	SAKARYA
SIEMENS	Intelligent Distributed **Cognitive-based Open Learning System** for Schools	IP	ISTANBUL
TOBB ETU	Group of Unmanned Assistant **Robots** Deployed in Aggregative Navigation Supported by **Scent Detection**	STREP	ANKARA
YOGURT TECHNOLOGIES	Integrated **Three-Dimensional Television** - Capture, Transmission and Display	NOE	ISTANBUL

The remaining mechanisms of FP6, such as CAs, SSAs, MCAs, and Era-Nets, are tackled as preparatory actions for conducting EU-wide collaborative R&D.

Moreover, three TÜBİTAK projects were excluded from the samples. This was done to avoid bias, since TÜBİTAK performs two functions together: R&D performance and R&D funding.

As a result, the sample comprises 39 entities: 21 university research groups, 14 firms and 4 spin-offs formed by academicians. The spin-offs are not seen in the European Commission database because the applications for FP6 were submitted by university partners.

Rather than taking projects from a certain university as one entity, I preferred to separate them at the level of research groups. For example, the sample has 5 research groups from Bilkent University (includes one spin-off, as well), 5 from METU (includes two spin-offs, as well), 4 from Koç University, 3 from Sabancı University and 2 from Boğaziçi University. In-depth analyses and reduction of the unit analysis level to research-group level provided an opportunity to notice such semi-academic, semi-professional entities. It was an enlightening step because it made possible the observance and comparison of different dynamics within the same university.

To trace the local and global performance of participating entities, two datasets were formed. This was necessary for estimation of the degree of local–global interactions in the nine years from 2004 to 2012.

The first dataset, called GP, was established using five data sources.

1. FP6 IST project database (FP6; Source: European Commission)
2. FP7 ICT project database (FP7; Source: European Commission)
3. Bilateral project database (BILAT; Source: TÜBİTAK)

4. COST project database (COST; Source: TÜBİTAK and COST)
5. Database for evaluators in FP6 and FP7 (GOVERNANCE; Source: European Commission)

The aggregate results, including the variety of the international mechanisms deployed, give semi-processed findings about the international orientation of the entity.

As mentioned before, each axis comprises three determinants. In line with this, the sum of the first four data sources will form the total value of the international project stock of an entity. It is a monetary value of the portion received from the total budget of the projects involved (Table 41 and Table 42).

Table 43: Sub-determinants for projects stock (international dimension)

Participant	FP6	FP7	EUREKA	COST	BILAT
U1	1.301.826	794.000		22.760	-
U2	305.518	157.200		-	-
U3	283.188	591.840		-	-
U4	292.974	785.296		-	-
U-F2	886.080	-		-	44.700
U5	440.366	-		120.515	413.183
U6	293.928	-		120.515	11.800
U7	38.662	-		-	-
U8	325.440	-		-	-
U9	215.246	166.048		-	-
U10	516.240	-		-	12.825
U11	274.052	-		-	241.590
U12	195.952	1.081.600		283.930	-
U13	294.028	1.444.672		-	240.672
U14	149.658	421.600		-	-
U-F3	248.548	-		344.039	39.100
U15	448.906	-		22.760	-
U-F1	3.368.920	6.932.350	4.054.800	-	416.880
U16	627.844	922.320		-	-
U17	9.800	-		-	-
U18	278.422	-		-	-
U19	393.724	438.040		-	47.740
U20	390.000	-		-	-
U21	478.000	-		-	-
U-F4	336.678	-		101.338	-
F1	159.600	275.000		-	-
F2	72.000	-		-	-
F3	153.120	-		-	-
F4	162.700	-		-	-
F5	364.000	-	3.692.700	-	-
F6	936.684	-		-	-
F7	486.014	703.126	739.500	-	-
F8	110.000	-		-	-
F9	508.000	-	9.551.356	-	-
F10	661.230	-		-	-
F11	172.328	-		-	-
F12	2.489.322	-		-	-
F13	837.100	-		-	-
F14	112.226	-		-	-
Mean	503.034	193.774	4.509.589	26.048	37.654
St.Dev	630.445	489.073	3.182.260	73.880	102.734

The result of the fifth data source is a numerical value that is the number of evaluation panels involved on behalf of the European Commission in FP6 and FP7. The values for each participating entity are listed under the GOVERNANCE column in Table 42.

The third determinant, which does not use any specific data sources, is the count of international mechanisms deployed by an entity, and it is represented under the VARIETY column of Table 42.

Table 44: Determinants for assigning international orientation intensity

Participant	PROJECT STOCK	GOVERNANCE	VARIETY
U1	2.118.586	-	3
U2	462.718	-	2
U3	875.028	3	3
U4	1.078.270	-	2
U-F2	930.780	-	2
U5	974.064	1	4
U6	426.243	1	4
U7	38.662	-	1
U8	325.440		1
U9	381.294	-	2
U10	529.065	-	2
U11	515.642	-	2
U12	1.561.482	3	4
U13	1.979.372	-	3
U14	571.258	-	2
U-F3	631.687	1	4
U15	471.666	-	2
U-F1	14.772.950	2	5
U16	1.550.164	1	3
U17	9.800	-	1
U18	278.422	2	2
U19	879.504	-	3
U20	390.000	-	1
U21	478.000	-	1
U-F4	438.016	2	3
F1	434.600	-	2
F2	72.000	-	1
F3	153.120	1	2
F4	162.700	-	1
F5	4.056.700	-	2
F6	936.684	-	1
F7	1.928.640	-	3
F8	110.000		1
F9	10.059.356	-	2
F10	661.230	-	1
F11	172.328	-	1
F12	2.489.322	-	1
F13	837.100	-	1
F14	112.226	-	1
Mean	1.406.516	0	2
St.Dev	2.734.027	1	1

The second dataset used in this study, called LB, is primarily based on TÜBİTAK data about funded projects under different mechanisms and supportive governance mechanisms like evaluation panels, reviews of projects and executive programme committee members related to the ICT field. The GL dataset also provides secondary contributions to LB if more than one Turkish organisation is funded in the same international project. In this respect, eight data sources covering nine years, 2004–2012, are used.

1. ARDEB database (ARDEB; Source: TÜBİTAK)
2. SAVTAG/KAMAG database (KMAG/STAG; Source: TÜBİTAK)
3. TEYDEB database (TYDB; Source: TÜBİTAK)
4. Database for evaluators, reviewers and programme committee members for ARDEB, TEYDEB, KAMAG/SAVTAG (GOVERNANCE; Source: TÜBİTAK)
5. Database for FP6 IST projects with more than one Turkish partner (FP6T; Source: European Commission)
6. Database for FP7 ICT Projects with more than one Turkish partner (FP7T; Source: European Commission)
7. Database for COST projects with more than one Turkish partner (COSTT; Source: TÜBİTAK and COST)
8. Database for EUREKA projects with more than one Turkish partner (EUREKAT; Source: TÜBİTAK)

Table 43 and Table 44 show the values for the determinants of local buzz, as was done with database GP and presented in Table 44 and Table 42.

Table 45: Sub-determinants for projects stock (local dimension)

Participant	FP6T	FP7T	EurekaT/COSTT	ARDB	KMAG/SVTAG	TYDB
U1	1.301.826	-	22.760	-		-
U2	-	-	-	387.904		-
U3	283.188	-	-	929.750	1.604.814	-
U4	292.974	368.464	-	169.835		-
U-F2	-	-	-	-	767.352	72.505
U5	-	-	-	471.400		-
U6	293.928	-	-	194.000		-
U7	-	-	-	9.500		-
U8	-	-	-	-		-
U9	215.246	166.048	-	255.505		-
U10	516.240	-	-	287.154		-
U11	274.052	-	-	-		-
U12	195.952	597.600	101.338	-	316.708	-
U13	294.028	-	-	1.817.088		-
U14	149.658	-	-	621.493		-
U-F3	-	-	-	1.480.844	4.440.856	742.060
U15	448.906	-	22.760	170.220		-
U-F1	3.368.920	1.020.732	215.701	113.580		483.870
U16	-	-	-	193.600		-
U17	9.800	-	-	-		-
U18	-	-	-	1.090.218		-
U19	-	438.040	-	97.324		-
U20	-	-	-	-	702.011	-
U21	-	-	-	264.500		-
U-F4	336.678	-	101.338	-		-
F1	-	-		-		94.133
F2	72.000	-		-		90.695
F3	-	-		-		-
F4	-	-		-		2.403.219
F5	364.000	-	792.810	-		2.164.686
F6	936.684	-		-		-
F7	486.014	-		-		2.830.072
F8	-	-		-		-
F9	-	-	858.864	-		654.725
F10	661.230	-		-		-
F11	172.328	-		-		-
F12	2.489.322	-		-		807.317
F13	837.100	-		-		2.593.400
F14	112.226	-		-		-
Mean	**361.853,8**	**66.432,9**	**78.354,5**	**219.331,2**	**1.566.348,0**	**331.709,8**
St.Dev	**673.083,2**	**201.412,7**	**216.754,9**	**417.674,2**	**1.497.421,1**	**764.478,8**

Table 46: Determinants for assigning local orientation intensity

Participant	PROJECT STOCK	GOVERNANCE	VARIETY
U1	1.324.586	5	2
U2	387.904	27	3
U3	2.817.752	2	4
U4	831.273	26	5
U-F2	839.857	48	2
U5	471.400	19	3
U6	487.928	49	3
U7	9.500	3	2
U8	-	11	-
U9	636.799	34	6
U10	803.394	15	5
U11	274.052	13	2
U12	1.211.598	13	4
U13	2.111.116	30	4
U14	771.151	30	3
U-F3	6.663.760	15	5
U15	641.886	30	3
U-F1	5.202.803	5	5
U16	193.600	10	2
U17	9.800	1	1
U18	1.090.218	46	3
U19	535.364	50	3
U20	702.011	28	2
U21	264.500	23	3
U-F4	438.016	20	2
F1	94.133	-	1
F2	162.695	-	2
F3	-	-	-
F4	2.403.219	-	1
F5	3.321.496	-	2
F6	936.684	-	1
F7	3.316.086	-	2
F8	-	-	-
F9	1.513.589	-	1
F10	661.230	-	1
F11	172.328	-	1
F12	3.296.639	-	2
F13	3.430.500	-	2
F14	112.226	-	1
Mean	**1.234.387,0**	**14,2**	**2,4**
St.Dev	**1.503.842,0**	**15,9**	**1,5**

As seen from the construction of the data sources, the idea is to track the local and global activities of Turkish participants of FP6 IST for the period after they received funding from the European Commission. Based on the aggregate findings, Table 42 will constitute the x-axis while Table 44 forms the y-axis.

Methodology

This analysis is focused on local and global dynamics of Turkish organisations participating in the FP6 IST field.

Using the data sources presented before, a bi-dimensional index was built to plot the Turkish entities in terms of their local–global orientations.

The index has two axes and each axis is formed by three determinants. These are project stock, involvement in R&D governance bodies (such as being a panellist for the evaluation of R&D proposals) and the variety of mechanisms used for each dimension. The determinants are built from related sub-fields. For example, the PROJECT STOCK determinant is a summation of grants obtained from different funding bodies.

The aggregate findings for each determinant were normalised with Z-scores. The Z-score can be calculated as:

$$z = \frac{x - \mu}{\sigma}, \qquad (4)$$

where μ is the mean of the population and σ is the standard deviation of the population.Z-scores allow two different distributions to be compared in a standard way. Z-scores make possible to sum up the findings of different determinants and to make comparisons or rankings.

For each dimension of the index, the formulas are shown below:

$$Z(LB) = Z(\text{PROJECT STOCK}_{LB}) + Z(\text{GOVERNANCE}_{LB}) + Z(\text{VARIETY}_{LB}) \quad (5)$$

$$Z(GP) = Z(\text{PROJECT STOCK}_{GP}) + Z(\text{GOVERNANCE}_{GP}) + Z(\text{VARIETY}_{GP}) \quad (6)$$

The findings for the Z-score transformation of each axis are listed in following two tables (Table 45 and Table 46):

Table 47: Z-scores for Local Buzz focus

PARTICIPAN	Z(PROJECTS STOCK)	Z(GOVERNANCE)	Z (VARIETY)	**Z (LB)**
U1	0,04	-0,58	-0,93	-1,47
U2	-0,57	0,81	0,41	0,64
U3	1,01	-0,76	1,08	1,32
U4	-0,16	0,74	1,75	2,33
U-F2	-0,28	2,12	-0,26	1,59
U5	-0,52	0,30	0,41	0,20
U6	-0,51	2,19	0,41	2,09
U7	-0,82	-0,70	-0,26	-1,78
U8	-0,82	-0,20	-1,59	-2,62
U9	-0,36	1,24	2,42	3,31
U10	-0,30	0,05	1,75	1,50
U11	-0,65	-0,07	-0,26	-0,98
U12	0,16	-0,07	1,08	1,16
U13	0,55	0,99	1,08	2,62
U14	-0,32	0,99	0,41	1,08
U-F3	3,51	0,05	1,75	5,31
U15	-0,41	0,99	0,41	1,00
U-F1	2,89	-0,58	1,75	4,07
U16	-0,70	-0,26	-0,26	-1,22
U17	-0,82	-0,83	-0,93	-2,57
U18	-0,12	2,00	0,41	2,29
U19	-0,33	2,25	0,41	2,33
U20	-0,37	0,87	-0,26	0,24
U21	-0,65	0,55	0,41	0,31
U-F4	-0,54	0,37	-0,26	-0,43
F1	-0,76	-0,89	-0,93	-2,58
F2	-0,72	-0,89	-0,26	-1,87
F3	-0,82	-0,89	-1,59	-3,31
F4	0,74	-0,89	-0,93	-1,08
F5	1,34	-0,89	-0,26	0,19
F6	-0,22	-0,89	-0,93	-2,03
F7	1,33	-0,89	-0,26	0,19
F8	-0,82	-0,89	-1,59	-3,31
F9	0,16	-0,89	-0,93	-1,66
F10	-0,39	-0,89	-0,93	-2,21
F11	-0,71	-0,89	-0,93	-2,53
F12	1,32	-0,89	-0,26	0,17
F13	1,41	-0,89	-0,26	0,26
F14	-0,75	-0,89	-0,93	-2,57

Table 48: Z-scores for Global Pipelines focus

PARTICIPANT	Z(PROJECTS STOCK)	Z(GOVERNANCE)	Z (VARIETY)	Z (GP)
U1	-0,54	0,05	0,83	0,34
U2	-0,54	-0,34	-0,09	-0,98
U3	2,96	-0,25	0,83	3,55
U4	-0,54	-0,20	-0,09	-0,83
U-F2	-0,54	-0,22	-0,09	-0,86
U5	0,63	-0,10	1,75	2,29
U6	0,63	-0,32	1,75	2,06
U7	-0,54	-0,44	-1,02	-2,00
U8	-0,54	-0,38	-1,02	-1,93
U9	-0,54	-0,36	-0,09	-0,99
U10	-0,54	-0,33	-0,09	-0,96
U11	-0,54	-0,28	-0,09	-0,91
U12	2,96	-0,02	1,75	4,70
U13	-0,54	0,07	0,83	0,36
U14	-0,54	-0,32	-0,09	-0,95
U-F3	0,63	-0,22	1,75	2,17
U15	-0,54	-0,34	-0,09	-0,97
U-F1	1,80	4,06	2,68	8,53
U16	0,63	-0,09	0,83	1,37
U17	-0,54	-0,45	-1,02	-2,01
U18	1,80	-0,39	-0,09	1,31
U19	-0,54	-0,24	0,83	0,06
U20	-0,54	-0,36	-1,02	-1,92
U21	-0,54	-0,34	-1,02	-1,90
U-F4	1,80	-0,33	0,83	2,30
F1	-0,54	-0,35	-0,09	-0,98
F2	-0,54	-0,44	-1,02	-1,99
F3	0,63	-0,42	-0,09	0,12
F4	-0,54	-0,41	-1,02	-1,97
F5	-0,54	1,36	-0,09	0,73
F6	-0,54	-0,23	-1,02	-1,79
F7	-0,54	0,17	0,83	0,47
F8	-0,54	-0,43	-1,02	-1,98
F9	-0,54	4,14	-0,09	3,51
F10	-0,54	-0,30	-1,02	-1,85
F11	-0,54	-0,41	-1,02	-1,97
F12	-0,54	0,13	-1,02	-1,43
F13	-0,54	-0,26	-1,02	-1,81
F14	-0,54	-0,43	-1,02	-1,98

Concerning the visualising of the findings 3×3 matrix was developed to show the degrees of local and global activities. Reflecting the summation of Z-scores of project stocks, involvement in governance mechanisms and cognitive proximity, the taxonomy considers 9 quadrants which are theoretical clusters for different degrees of local–global activity.

As it was desirable for the values for both axes to lie within the same interval (i.e. between 0 and 1) in the cluster analysis, they were standardised with min-max transformation after the Z-scores were calculated. The min-max transformation is the process of taking data in their units (for example, a monetary value) and transforming them to a value between 0 and 1. The formula for min-max transformation can be summarised as shown below.

$$I^{t}{}_{qc} = \left(\frac{x^{t}{}_{qc} - \min_{c}(x_{q}^{t})}{\max_{c}(x_{q}^{t_o}) - \min_{c}(x_{q}^{t})} \right) \qquad (7)$$

In the case of Turkey, seven of the nine theoretical groups are filled with different partners. The findings indicate that the nine years of R&D-related tracking of Turkish participant organisations in FP6 was rather heterogeneous in terms of density of local–global activities related to R&D.

For checking the validity of the model, a second model that includes different coefficients for each determinant was developed. The formulas for the second model are given below.

$$Z(LB^{*}) = Z(kX\ PROJECTS\ STOCK_{LB}) + Z(lX\ GOVERNANCE_{LB}) + Z(mX\ VARIETY_{LB}) \quad (8)$$

$$Z(GP^{*}) = Z(kX\ PROJECTS\ STOCK_{GP}) + Z(l\ X\ GOVERNANCE_{GP}) + Z(m\ X\ VARIETYGP) \quad (9)$$

The coefficients were developed with an analytic hierarchy process (AHP), which is a structured technique for organising and analysing complex decisions. The weighting was performed based on the views of 5 experts who have deep knowledge about the national and international R&D programmes available to Turkish researchers. The experts were asked to prioritise the mechanisms available for each dimension (i.e. the local axis and global axis). This process was guided by a series of judgments based on pairwise comparisons of the mechanisms. The method was practised for four criteria: scientific merit, difficulty in taking advantage of the mechanism, impact and ease of flow of knowledge. The macro-results of the assessments are shown in Table 47.

Table 49: Prioritisation of determinants for local buzz and global pipelines

Project stock	0,6	(k)
Governance	0,15	(l)
Variety	0,25	(m)

Moreover, examples of filled forms are listed in the following two tables (Tables 48 and 49):

Table 50: An Example of Filled Expert Assessment Form with Respect to the Mechanisms Targeting the Local Base

A/B		A			
		Bilimsel Önem	Mekanizmadan Yararlanmanın Zorluğu*	Etki	Bilgi yayılımı kolaylığı
		ARDEB projesinde yer almak	ARDEB projesinde yer almak	ARDEB projesinde yer almak	ARDEB projesinde yer almak
B	TEYDEB projesinde yer almak	2,0	2,0	0,7	2,0
	1007 projesinde yer almak	1,5	0,5	0,5	0,5
	6.ÇP/7.ÇP IP projesinde başka Türk ortaklarla yer almak	0,3	0,2	0,5	0,7
	6.ÇP/7.ÇP NoE projesinde başka Türk ortaklarla yer almak	0,3	0,2	0,5	0,5
	6.ÇP STREP/7.ÇP CP-FP projesinde başka Türk ortaklarla yer almak	0,5	0,5	0,7	0,7
	EUREKA projesinde başka Türk ortaklarla yer almak	1,5	1,0	0,7	0,5
	TEYDEB programları için hakem veya izleyici olmak	3,0	2,0	3,0	2,0
	1007 programı için hakem veya izleyici olmak	2,0	1,5	3,0	2,0
	ARDEB programları için panelist veya izleyici olmak	3,0	2,0	3,0	2,0
	ARDEB/TEYDEB'de Grup Yürütme ya da Danışma Komitesi üyesi olmak	0,3	0,5	1,5	0,5
	Yerel bilgi yayılımına yönelik birden fazla mekanizmada yer alıyor olmak (ulusal ekosistemde aktif olmak)	0,5	0,7	0,7	0,5

ÖNEM: Bu mekanizmadan desteklenmenin BİLİMSEL prestiji, bilimsel değeri vs.
ZORLUK: Adı geçen mekanizmadan destek alabilmek için sarfedilmesi gereken zaman dilimi, rekabetin yoğunluğu, dil ve kültürel sorunlar vs.
ETKİ: Adı geçen mekanizmadan yararlanma neticesinde ortaya çıkması muhtemel etki (bilgi üretimi, teknolojik etki, ekonomik etki)
YAYILIM: Adı geçen mekanizma aracılığıyla bilginin yayılma kolaylığının derecelendirilmesi

Örnek: D4 hücresinin anlamı 6.ÇP veya 7.ÇP'den destek almak COST'a göre iki daha ZORDUR.

Table 51: An Example of Filled Expert Assessment Form with Respect to the Mechanisms Targeting the International Base

A/B		A			
		Bilimsel Önem	Mekanizmadan Yararlanmanın Zorluğu*	Etki	Bilgi Yayılımı Kolaylığı
		6./7.ÇP NoE	6./7.ÇP NoE	6./7.ÇP NoE	6./7.ÇP NoE
B	6./7.ÇP IP	1,5	0,7	0,7	2,0
	6.ÇP STREP/7.ÇP CP-IP	2,0	2,0	1,5	3,0
	COST	1,5	2,0	1,5	1,0
	İkili Proje	4,0	4,0	4,0	4,0
	EUREKA	2,0	3,0	0,5	3,0
	Evaluator olmak (6.ÇP ve 7.ÇP)	3,0	2,0	5,0	3,0
	Birden fazla uluslararası mekanizmadan destek alabiliyor olmak	1,5	1,0	1,5	2,0

Researchers and firms of the sample were weighted based on their desires to conduct new research projects, involvement in governance mechanisms and local–global focus. Using such a grading method, it was shown whether the FP6 participants were still active in TÜBİTAK and European funding or governance mechanisms. This grading approach was used to weight each participating entity with respect to their current positions in national and international programmes. An example is given in Table 50. With this method, two-dimensional coefficients for each Turkish partner were obtained.

The coefficient shows the degree of the tendency of each partner for possible actions on a local and global basis. The coefficients are listed in Table 51.

Table 52: Grading Approach, An Example of Filled Form

FP katılımcısı şirket/araştırmacı	**Bu şirketlerin son dönemde FP ve EUREKA programlarına ilgisini nasıl değerlendiriyorsunuz?** (en yüksek: 10, en düşük: 1 puan NOT: Aynı puan birden fazla araştırmacıya şirkete verilebilir.
U1	7
U2	7
U3	5
U4	8
U-F2	6
U5	1
U6	1
U7	1
U8	6
U9	4
U10	1
U11	7
U12	9
U13	8
U14	8
U-F3	5
U15	5
U-F1	9
U16	8
U17	2
U18	5
U19	9
U20	2
U21	2
U-F4	7
F1	5
F2	1
F3	5
F4	4
F5	8
F6	5
F7	8
F8	7
F9	10
F10	10
F11	2
F12	4
F13	2
F14	4

Table 53: The degree of tendency for each partner about their possible actions (local and global)

Partner	Activity Tendency GB	Activity Tendency LB
U1	0,78	0,44
U2	0,78	0,67
U3	0,56	0,33
U4	0,89	0,78
U-F2	0,67	0,89
U5	0,44	0,56
U6	0,44	0,56
U7	0,09	0,22
U8	0,67	0,03
U9	0,44	0,67
U10	0,22	0,44
U11	0,78	0,22
U12	1,00	0,78
U13	0,89	0,67
U14	0,89	0,67
U-F3	0,56	0,89
U15	0,56	0,67
U-F1	1,00	0,22
U16	0,89	0,56
U17	0,22	0,22
U18	0,56	1,00
U19	1,00	1,00
U20	0,00	0,00
U21	0,22	1,00
U-F4	0,67	0,56
F1	0,56	0,56
F2	0,22	0,44
F3	0,56	0,78
F4	0,44	0,78
F5	0,89	0,78
F6	0,44	0,33
F7	0,67	0,67
F8	0,78	0,01
F9	1,11	0,33
F10	0,78	0,67
F11	0,22	0,44
F12	0,44	0,56
F13	0,22	0,56
F14	0,44	0,44

The results obtained from the first and second model was compared using Spearman's rank correlation:

$$\rho = 1 - \frac{6 \sum d_i^2}{n(n^2 - 1)}. \qquad (10)$$

Spearman's rank correlation coefficient, ρ, measures the direction and strength of a relationship between two ranked variables. The coefficient can have values between -1 and 1. The sign of the Spearman correlation indicates the direction of the association between two compared values (i.e. $Z(LB_1)$ and $Z(LB_2)$ in our case). If $Z(LB_1)$ tends to increase when $Z(LB_2)$ increases, the Spearman correlation coefficient is positive. If it is vice versa, the Spearman correlation coefficient is negative. A Spearman correlation of zero indicates that there is no tendency for two variables to attract each other.

After the processing of all data, 9 quadrants were drawn with respect to two models. Each quadrant was then separated into 9 parts with horizontal and vertical lines passing from the 25th to 75th percentile of each axis. A percentile is the value of a variable below which a certain percentage of observations fall. For example, the 25th percentile is the value below which 25% of the observations may found (Figure 19).

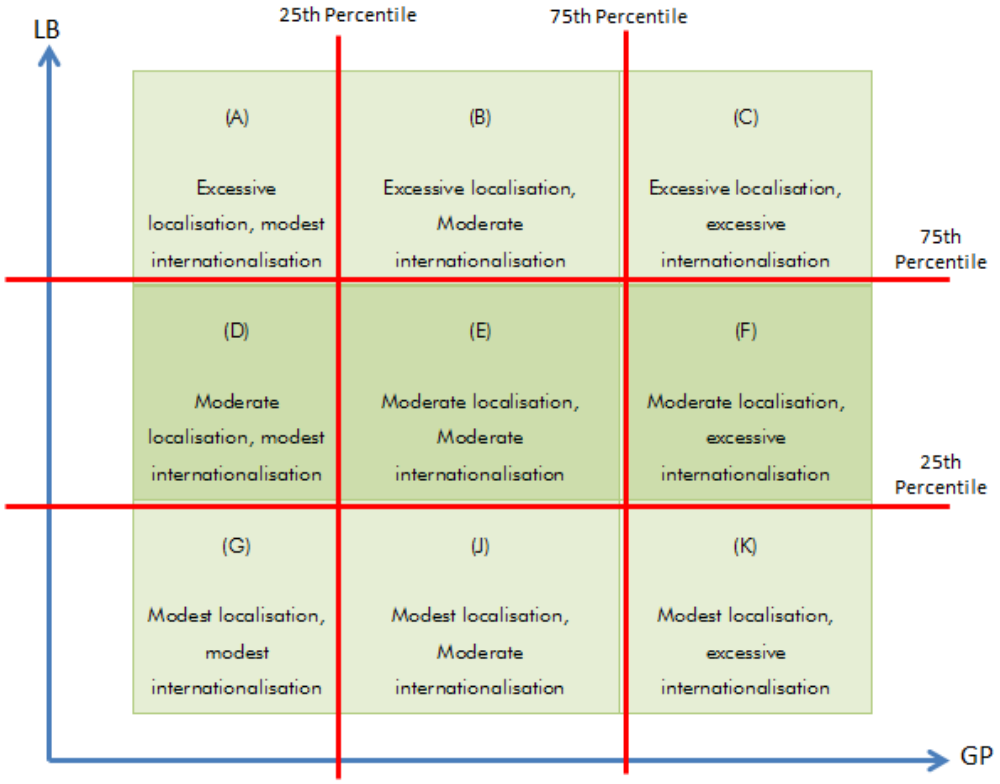


Figure 18: Conceptual framework for drawing the 9 quadrants

For both dimensions, Spearman rank correlation coefficients was calculated The coefficients are 0,98 for the global dimension and 0,87 for the local one. These results indicate that both of the indexes provide similar results, which can be taken as a sign of the strength of the index. The calculations are listed in Tables 52 and 53, and also Model 1 and Model 2 are visualised in Figures 20 and 21 respectively.

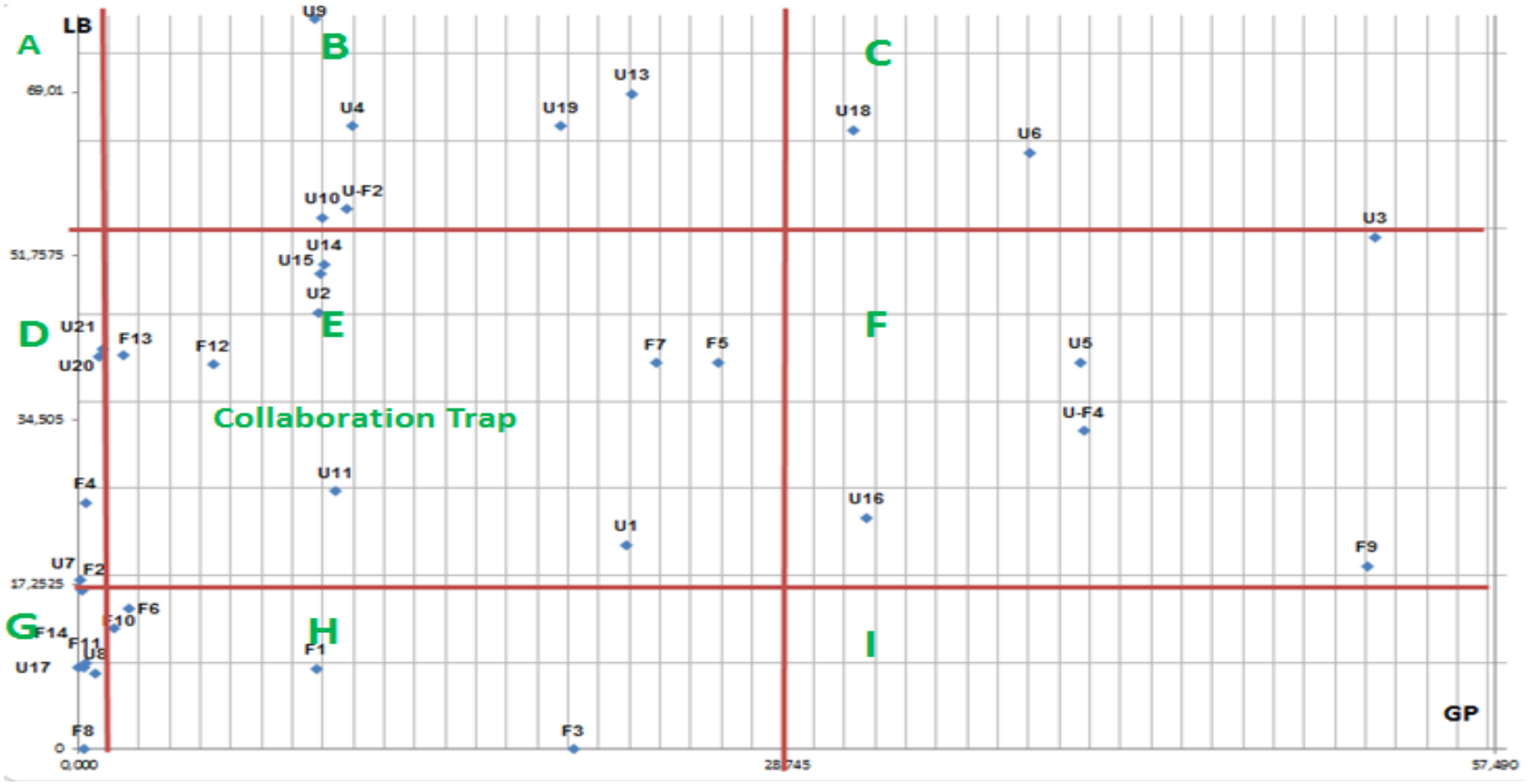
Table 54: Spearman's Rank Correlation Coefficient calculation for Global Pipelines axis

	x-GP--(1)	x-GP--(2)	Rank 1	Rank 2	Diff	Diff*^2
U-F1	100,00	100,00	1	1	0	0
F9	52,35	65,58	4	2	2	4
U12	63,61	36,10	2	3	-1	1
U3	52,68	25,60	3	4	-1	1
F5	25,98	24,74	11	5	6	36
U5	40,72	22,36	6	6	0	0
U-F3	39,63	22,27	7	7	0	0
U6	38,61	21,48	8	8	0	0
U16	32,04	21,32	9	9	0	0
U-F4	40,86	20,62	5	10	-5	25
U13	22,46	18,64	13	11	2	4
U1	22,29	18,39	14	12	2	4
F7	23,46	17,21	12	13	-1	1
U19	19,59	14,87	16	14	2	4
U18	31,51	14,48	10	15	-5	25
F3	20,16	10,02	15	16	-1	1
U4	11,15	9,80	17	17	0	0
U-F2	10,92	8,24	18	18	0	0
U14	10,02	7,77	20	19	1	1
U2	9,78	7,10	23	20	3	9
U11	10,44	7,07	19	21	-2	4
U15	9,85	6,67	22	22	0	0
F1	9,72	6,57	24	23	1	1
U9	9,60	6,25	25	24	1	1
U10	9,96	6,01	21	25	-4	16
F12	5,51	4,98	26	26	0	0
F10	1,45	2,32	29	27	2	4
F6	2,06	1,87	27	28	-1	1
U8	0,70	0,98	32	29	3	9
F13	1,84	0,83	28	30	-2	4
U21	1,04	0,48	30	31	-1	1
F8	0,22	0,39	36	32	4	16
F4	0,34	0,33	34	33	1	1
F14	0,23	0,22	35	34	1	1
F11	0,36	0,17	33	35	-2	4
F2	0,14	0,07	37	36	1	1
U7	0,06	0,02	38	37	1	1
U17	0,00	0,01	39	38	1	1
U20	0,85	0,00	31	39	-8	64
					Sum d	246
				A	6*Sum d	1476
					Count	39
					n*^2-1	1520
				B	n(n*^2-1)	59280
					A/B	0,02
					1-A/B	0,98

Table 55: Spearman's Rank Correlation Coefficient calculation for Local Buzz axis

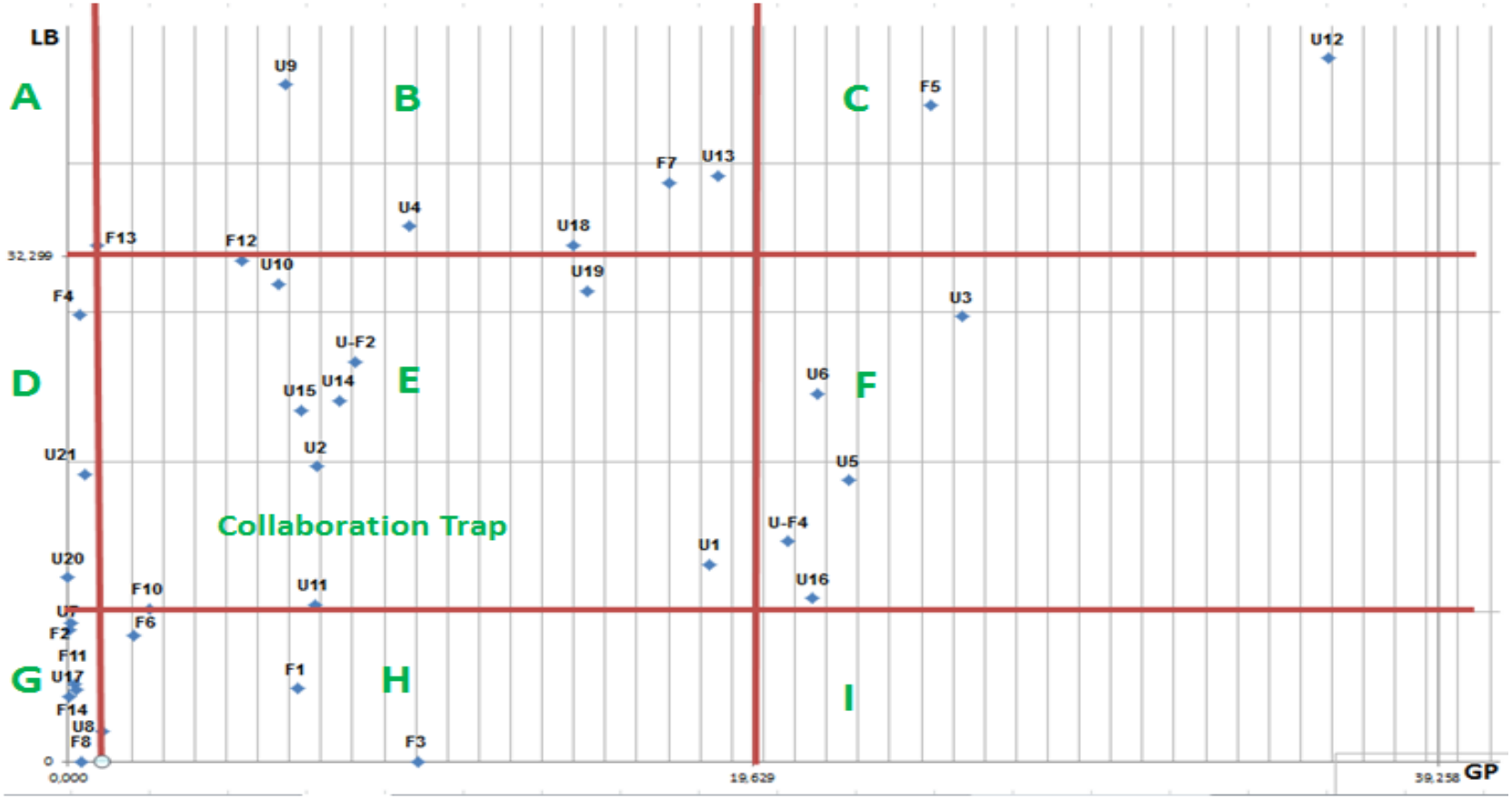
	y-LB--(1)	y-LB--(2)	Rank 1	Rank 2	Diff	Diff*^2
U-F3	100,00	100,00	1	1	0	0
U12	51,89	44,93	12	2	10	100
U9	76,73	43,25	3	3	0	0
F5	40,58	41,92	20	4	16	256
U13	68,81	37,42	4	5	-1	1
U-F1	85,54	37,28	2	6	-4	16
F7	40,54	37,00	21	7	14	196
U4	65,38	34,20	6	8	-2	4
U18	65,00	33,02	7	9	-2	4
F13	41,40	32,98	17	10	7	49
F12	40,39	32,00	22	11	11	121
U10	55,77	30,48	10	12	-2	4
U19	65,38	30,04	5	13	-8	64
F4	25,89	28,56	25	14	11	121
U3	53,75	28,42	11	15	-4	16
U-F2	56,81	25,55	9	16	-7	49
U6	62,64	23,53	8	17	-9	81
U14	50,94	23,03	13	18	-5	25
U15	49,96	22,42	14	19	-5	25
U2	45,86	18,84	15	20	-5	25
U21	42,01	18,36	16	21	-5	25
U5	40,66	17,94	19	22	-3	9
U-F4	33,38	14,04	23	23	0	0
U1	21,40	12,58	27	24	3	9
U20	41,20	11,74	18	25	-7	49
F9	19,18	10,58	28	26	2	4
U16	24,26	10,41	26	27	-1	1
U11	27,05	10,03	24	28	-4	16
F10	12,75	9,75	32	29	3	9
F2	16,74	8,85	30	30	0	0
U7	17,77	8,38	29	31	-2	4
F6	14,83	8,05	31	32	-1	1
F11	9,06	4,96	33	33	0	0
F1	8,47	4,64	36	34	2	4
F14	8,60	4,60	34	35	-1	1
U17	8,56	4,15	35	36	-1	1
U8	8,01	1,95	37	37	0	0
F3	0,00	0,00	38	38	0	0
F8	0,00	0,00	39	39	0	0
					Sum d	1290
				A	6*Sum d	7740
					Count	39
					n*^2-1	1520
				B	n(n*^2-1)	59280
					A/B	0,13
					1-A/B	0,87

Figure 19: Clustering of 39 Turkish organisations with respect to local-global dimension of collaboration networks, 2004–2012 (Model 1)



[64]U1,U2...Un: Partners from universities; F1, F2,...Fn: Firms; U-F1, U-F2...U-Fn: Spin-offs founded by university researchers.

Figure 20: Clustering of 39 Turkish organisations with respect to local-global dimension of collaboration networks, 2004–2012 (Model 2)



APPENDIX C: TURKISH SUMMARY

ULUSLARARASI AR-GE ŞEBEKELERİNE KATILIM YEREL DİNAMİZMİ ARTIRIR MI? TÜRKİYE'DEN ARAŞTIRMACI DÜZEYİNDE ÇIKARIMLAR

Bu çalışma küresel işbirlikleri yerel yerel hareketlilik doğurur mu sorusuna 6.Çerçeve Programı (6.ÇP) ağları ve TÜBİTAK tarafından finanse edilen BİT araştırmacılarının projelerini inceleyerek yanıt oluşturmaktadır.

Çalışma ayrıca Türkiye'de bilgi ve iletişim teknolojileri bilim adamlarının küreselleşme-yerelleşme derecesini belirlemek için yeni bir sınıflandırma sağlamaktadır.

Hem yerel hem de uluslararası Ar-Ge fonlarının mevcut olduğu bir ortamda araştırmacılar ulusal bazda ya da küresel ölçekte çalışmayı tercih edebilirler veya ikisi arasında dengeleri bir duruş da sergileyebilirler. Araştırmacıları hangi ölçeğe daha çok ilgi duyduklarını görmek için birbirini takip eden iki farklı zaman diliminde ulusal ve uluslararası proje bazlı birikimlerini 2003-2006 verileri çerçevesinde haritalandırdık. Farklı katılım düzeylerine göre de dört grup oluşturduk. Oluşturulan bu grupların 2007-2013 yılları için ulusal ve uluslararası projeler, yayın çıktıları, ulusal seviyedeki Ar-Ge yönetişimi çalışmalara katkı, özel sektör Ar-Ge kapasitesinin gelişimi için ortaya konan çalışmalar gibi beş boyutta performansları ölçüldü.

Sayısal çalışmanın bulguları her iki yönde de etkin olan araştırmacıların popülasyonun en başarılı Bilim insanları olduklarını ortaya koyuyor. Bulgular ayrıca. AB Ar-Ge ağlarının çevresinde olan bir ülkenin uluslararası ortakları güçlü olan araştırmacıların yerel araştırma tabanına önemli ölçüde katkıda bulunduklarını ortaya koymaktadır. Bu uluslararası işbirliği yapan araştırmacıların çoğunun yerel olarak da aktif olduğu anlamına gelir. Ayrıca,

sadece 2003-2006 döneminde ulusal düzeyde aktif olanların, 2007-2013 döneminde uluslararası faaliyetlerinin gelişmiş olduğu anlaşılmaktadır.

Çalışmada ayrıca ulusal ve uluslararası düzeyde güçlü bir proje portföyüne sahip olanların i) Doktora sonrası iş deneyimi ve ii) Türkiye'de ileri araştırma ekosistem olan bir üniversite çalışıyor olmaları ile ilişkili oldukları ortaya konmaktadır.

BİT araştırmacıların karakterizasyonu için daha ayrıntılı bulgular elde etmek için, Türkiye'de güncel dinamikler konusunda tematik ya da bütünsel bir anlayışa sahip araştırma ekosisteminin kilit oyuncular ile derinlemesine görüşme ve odak grup toplantıları yapılmıştır.

Küresel ve yerel etkileşimlere katılımı dengeleme konusunda sağlam bir zemin sağlayan nitel sonuçları tezin son kısmını oluşturmakta olup, mikro, mezo ve makro düzeyde pratik politika önerileri ortaya konmaktadır.

Politika önerileri araştırmacıların performans takibinin yapılmasına ihtiyaç olduğunu ifade etmektedir. Kronolojik veri analizi ile gelen deliller tek bedene uyan uyan yaklaşımlar yerine farklı aktörler arasında heterojenliği, farklı kariyer seviyelerini, ulusal öncelikleri, araştırma ekosistemin kapasite ihtiyaçlarını dikkate alan ve farklı aktörler arası sinerji oluşturmaya politikalara olan ihtiyacı ortaya koymaktadır.

Bu çalışmanın temel amacı, AB ve TÜBİTAK tarafından finanse edilen bilgi ve iletişim teknolojileri alanındaki uluslararası Ar-Ge işbirliği projelerinde yer alan Türk araştırmacıların yerel düzeyde oluşturdukları hareketliliğin derecesini ortaya koymaktır. Diğer bir deyişle, bu tez Türk BİT araştırmacıları özelinde küresel hatlarda yer almanın yerel etkileri ile ilgilidir. Tez, gelişen bir ekonominin inovasyon sisteminde hem küresel hem de yerel düzeyde bütünleşmiş olmuş araştırmacıların rolünü belgelemektedir.

Genel olarak, yerel ve küresel unsurları dengeli bir birleşim içinde yoğurabilen araştırma ekosistemde bilgi üretiminin olduğu kabul edilmektedir (Bathelt, 2007). Bu çalışma "küresel hatlar-yerel hareketlilik" yaklaşımı çerçevesinde uluslararası Ar-Ge işbirliği yapmak için oluşturulan ağlara katılan gelişmekte olan ekonomilerindeki üniversite araştırmacıların durumlarını ve görev yaptıkları üniversitelerin yaklaşımlarını irdelemektedir. Çoğunlukla ulusal fonlardan yararlanan ve genellikle uluslararası Ar-Ge ağlarında rol hakim rolü olmayan gelişmekte olan bir ekonomideki üniversitelerin araştırma dinamikleri hakkında ipuçları vermektedir. Barnard ve diğerleri (2012) küresel hatlar-yerel hareketlilik yaklaşımını bilimsel makalelerde uygularken, bu tez aynı yaklaşımı ulusal ya da uluslararası yapılar tarafından desteklenen projeler üzerinden ele alırken, temel analiz birim akademisyenlerdir. Gelişen ekonomilerdeki akademisyenlerin proje performanslarını küresel hatlar-yerel hareketlilik yaklaşımı çerçevesinde analiz eden bu tür bir yaklaşım biyoteknoloji, ilaç ve bilgi ve iletişim teknolojilerinde uluslararası işbirliği ağları için öncü kabul edilebilir. Zira, bu alanlardaki ağlar genellikle gelişmiş ülke kuruluşlarının dominasyonunda olup, analiz çalışmaları da doğal olarak bu ülke grubunda ülkeleri kapsamaktadır. Gelişen ekonomilerdeki üniversitelerin araştırma dinamikleri hakkındaki çalışmaların eksikliği göz önüne alındığında, bu çalışma, uluslararası işbirliğinin yerel etkisine vurgu yaparak, bununla beraber mikro, mezo ve makro düzeyde pratik politika önerileri geliştirerek, araştırmanın uluslararasılaşması tartışmalarına katkı üretmeyi hedeflemektedir.

Yenilik kavramına evrimsel açıdan bakıldığında, araştırma işbirliği ve dış bilgi akışları yeni yetenekler elde etmek için önemli bir katalizör olarak görülmekte olup, inovatif kurumların sadece iç bilgi tabanıyla yetinmeleri mümkün görünmemektedir. Bu tezde takip edilen teorik çerçeve evrimsel ekonomi, ekonomik kalkınma merkez-çevre modeli, araştırma ağları, gelişen ekonomilerde bilimin yapılanması ve sosyolojisi konularındaki yenilikçi çağdaş çalışmalara dayanmaktadır. Ekonomik coğrafyaya ilişkin Krugman'ın merkez-çevre modelini de dikkate alarak, bu çalışmada uluslararası Ar-Ge

ağlardan toplanan bilginin yerel yayılımı irdelenmekte ve işbirliği ağlarında merkezi bir pozisyonu olmayan ülkeler için politika önerileri sunulmaktadır. Krugman'ın ekonomik coğrafyaya ilişkin merkez-çevre modeli çerçevesinde, bu çalışma uluslararası Ar-Ge ağlardan toplanan bilginin yerel yayılımı üzerine odaklanmakta olup, bu ağların merkezinde olmayan ülkeler için politika önerileri geliştirmektedir. Bu kapsamda yerelle küresel ölçek arasında ne tip sinerjiler oluşturulabileceğine dair de fikirler sunulmaktadır.

Tezde AB tarafından fonlanan Ar-Ge ağlarında veya TÜBİTAK tarafından desteklenen uluslararası işbirliği projelerinde yer alan BİT akademisyeni verileri için 2003-2012 yıllarını kapsayacak şekilde kantitatif ve kalitatif yöntemler kullanılmaktadır. Malerba ve diğerleri (2006) gibi bilgi ve iletişim teknolojileri konusuna AB düzeyinde odaklanan diğer araştırmalardan farklı olarak, bu çalışmada araştırmacı düzeyinde yerellik ve küresellik dereceleri belirlenmektedir. Sözkonusu derecelendirmeyi yapabilmek için BİT araştırmacılarının proje portföyleri iki zaman aralıkları içinde bölünerek analiz edilmektedir. Birinci dönem 6.ÇP'yi kapsayan 2003 ile 2006 arasındadır. Benzer şekilde, ikinci zaman aralığı Temmuz 2013'e kadar geçen 7.ÇP dönemini kapsamaktadır.

Burada uluslararası işbirliği faaliyetine katıldıktan sonra araştırmacının ne tip adımlar attığının, yani takip ettiği patikanın mercek altında tutulması önem arzetmektedir. Bu nedenle, farklı veri setlerinin bütünleştirilmesi sonucunda yapılan betimsel analiz ışığında araştırmacıların küresel-yerel odaklanma yoğunluklarını eşleştirme imkanı sağlayan taksonomi geliştirilmiştir. Farklı grupların, belli bir zaman aralığı içinde farklı araştırma olabileceği savı çerçevesinde Graf (2011)'e benzer taksonomi geliştirilmiştir.

Graf (2011)'deki sınıflandırmaya benzer taksonomi oluşturularak dörtlü bir gruplama yapılmış olup, aynı zaman dilimi içinde farklı grupların farklı bilimsel çıktıları olduğu savunulmaktadır. Bu argüman, uluslararası veya ulusal proje yoğunluğu, yayın çıkışı, ulusal yönetim organları katılımı ve 2007-2013

dönemi için özel sektör Ar-Ge kapasitesinin gelişmesine katkı gibi temel göstergeler bazında test edilmektedir. Gruplar arasında farklılıklar ve benzerlikler iki örneklemli t-testi kullanılarak analiz edilmektedir.

Araştırmacıların küresel ve yerel tabanlı proje portföyleri konumlandırma için dört grup gerekçesi sonra, çalışma, gruplaşma var neden üzerinde odaklanır. Araştırmacı bazında yerel ve küresel proje portföyü verisi analiz edilerek dörtlü gruplama gerekçelendirildikten sonar, neden böyle bir gruplamanın olduğuna odaklanılarak istatistiksel olarak anlamlı sonuçlar bulunup bulunulamayacağı test edilmektedir.

Bu bölüm 2003 ve 2013 yılları arasında dönemini bir bütün olarak kapsamakta olup, doktora eğitiminin, 2003 öncesi bilimsel makale üretiminin, üniversitenin araştırma ekosisteminin, doktora sonrası yurtdışı iş tecrübesinin dört grup için farklılıklar ya da benzerlikler içerip içermediği sorgulanmaktadır. Bu bölümde de yine iki örneklemli t-testi kullanılmaktadır.

Kantitatif çalışma kalitatif analizle daha bütüncül anlam kazanmakta olup, kalitatif kısım derinlemesine görüşme ve odak grup bulguları üzerine inşa edilmektedir. Bu bölümde bir inovasyon sisteminin gelişiminde üniversitenin yeri küresel hatlar-yerel hareketlilik yaklaşımı çerçevesinde uluslararasılaşma kavramını da içine alacak şekilde irdelenmektedir.

Tezin orijinalliğini iki açıdan vurgulamak mümkündür: İlk olarak, tez küresel hatların istatistiksel olarak anlamlı bir yerel hareketlilik doğurup doğurmadığını ele almakta bu yönüyle yerel hareketlilik-küresel hatlar kavramına kışkırtıcı bir boyut kazandırmaktadır. İkinci olarak, bu çalışma uluslararası Ar-Ge işbirliği ağlarında yer alan Türk araştırmacıların durumunu ulusal araştırma düzeyi ile bağlayan ilk kapsamlı girişimdir

Günümüzde, uluslararası Ar-Ge işbirliği süreçlerine yönelik çalışmaların önemli bir kısmı gelişmiş ülke kuruluşlarının kendi aralarındaki bağları irdelemektedir, zira literatürün önemli bir kısmı da gelişmiş ekonomilerde yer

alan örgütlerin kendi aralarında oluşturdukları ağlar üzerinden şekillenmektedir. Başka bir deyişle mevcut çalışmaların büyük çoğunluğu gelişmiş ekonomilerin kendi aralarındaki bilgi akışını ele almaktadır. İşbirliği ağlarına ilişkin resmedilen bu tabloda, gelişen ekonomilerin Ar-Ge işbirliği ağlarından ne şekilde istifade ettikleri konusu araştırılması gereken bir konu olarak karşımıza çıkmaktadır. Bununla beraber özellikle AB ülkeleri dikkate alındığında Çerçeve Programları gibi makro yaklaşımların bu programlara katılan ve diğerlerine göre daha geri kalmış ülkelerin lehine dışsallıklar oluşturduğuna dair yeterince kanıt yoktur.

ODTÜ-TEKPOL tarafından yürütülen çalışmada Türk BİT kuruluşlarının AB ağlarındaki pozisyonlaması ortaya konmaktadır (Erdil ve diğerleri, 2011)[65]. Bu çalışma aynı zamanda ülkemizin BİT araştırma potansiyelini ortaya koymakta olup, bununla beraber Çerçeve Programlarında yaşanan sıkıntı ve engellere de vurgu yapmaktadır. Çalışmada ayrıca BİT için mevcut olan mevzuat ve politika çerçevesi de ele alınmakta olup, mükemmeliyet merkezi olabilecek yerler de analiz edilmektedir. Araştırmada delfi analizi kullanılarak BİT ekosistemini oluşturan paydaşların görüşleri çerçevesinde kuruluş, ulusal ve AB düzeyinde politika önerileri sunulmaktadır.

Bu tezden farklı olarak ODTÜ-TEKPOL çalışması BİT ekosistemimizin AB düzeyindeki yerine ilişkin bir konumlandırma yapmakla beraber, bunu ulusal düzeyle güçlü bir şekilde ilişkilendirmemekte, yani ulusal ve uluslararası konumumuz arasında kıyaslanabilir bir çerçeve sunmamaktadır.

Ülkemizde ağlara ilişkin yapılan önceki çalışmalarda daha çok ulusal bazdaki işbirlikleri ele alınmakta olup, uluslararasılaşma dinamiklerine çok fazla yer verilmemektedir. Erdil ve Çetin (2008); Armatlı-Köroğlu (2004), (METU TEKPOL, 2008) gibi çalışmalar Türk kuruluşların kendi içindeki etkileşimlerine veya yerel ağlara odaklanmaktadır. Geçmiş çalışmalardan

[65] http://stps.metu.edu.tr/ict-rtd-technological-audit-turkey Erişim tarihi: 30 Eylül 2013.

farklı olarak bu tezde Türk araştırmacılarının uluslararası ağlara katılımı da incelenmekte olup, uluslararası işbirliklerinin yerel etkileri konusu da bir çerçeve içerisinde sorgulanmaktadır.

Farklı işbirliklerinde yer alan araştırmacıları farklı projeler arasında bilgi tutucular olarak ele almak mümkündür. Bu tür araştırmacılar uluslararası platformlarda elde ettikleri bilgileri yerel düzeye taşıyabilirler. Öte yandan tersi de mümkündür, yani bilgi tutucu hüviyetindeki bu kişilerin yerel bilgiyi uluslararası düzeye de aktarabilirler. Böyle bir durumda, uluslararası ağların yerel rekabet düzeyini olumsuz etkileme ihtimali de sözkonusu olabilecektir. Üçüncü bir alternatif olarak bir araştırmacı daha çok uluslararası ağlarla çalışmayı seçebilir. Bu durumda uluslararası ağdan kazanılan bilgi başka bir uluslararası ağa transfer edilecektir. Bu noktada da uluslararası bilgininin yerel kapasite gelişimine anlamlı bir katkı üretmesi pek mümkün gözükmemektedir.

Yukarıda zikredilen hususları da dikkate alarak bu tezin ana araştırma sorusu, uluslararası ağlara katılımının Türkiye BİT sektörü örneğin anlamlı bir yerel hareketlilik oluşturup oluşturmadığıdır. Bu sorunun cevabı, ülkemizin Çerçeve Programları veya uluslararası işbirliğini açıkça destekleyen diğer ulusal destek mekanizmalarından fonlanan projeler temelinde aranmaktadır.

Alt sorular olarak da şunları ifade etmek mümkündür:

- Türk BİT araştırmacılarını ulusal ve uluslararası proje yoğunluklarına nasıl bir çerçeve içerisinde kıyaslayabiliriz?
- Ulusal-uluslararası odaklanma düzeylerindeki benzerlikler veya farklılıklar araştırmacı bazında ne şekilde açıklanabilir?
- Önde gelen üniversitelerimiz ulusal/uluslararası odaklanmalarını nasıl bir karma içerisinde ele alıyorlar?
- Bulgulardan ne tür politika önerileri geliştirilebilir?

Yukarıdaki sorular ışığında bu tezde araştırmacıların ulusal veya uluslararası odaklanmalarını bir çerçeve içinde ele alan model geliştirilmektedir. Bununla beraber kalitatif araştırmanın çıktıları çerçevesinde araştırmacı ve üniversite düzeyinde işbirliği karmasının doğru bir şekilde konumlandırılmasına ilişkin olarak mikro, mezo ve makro düzeyde politika önerileri ortaya konmaktadır.

Tezde ayrıca şu detay soruların da cevapları aranmaktadır:

4. Araştırmacıların proje portföyleri ulusal ve uluslararası işbirlikleri bazında ne şekilde kıyaslanabilir?
5. Araştırma geçmişi ve görev yapılan üniversitenin sağladığı ekosistemin anlamlı bir etkisi var mıdır?
6. BİT sektöründeki araştırmacıların daha çok bilimsel çıktı üretmesinin engelleyen faktörler var mıdır?

Son yıllarda ağ çalışmaları akademik dünyada ciddi bir popülerlik kazandı. Zira, AB Çerçeve Programları kapsamındaki oluşturulan ağlara ilişkin makale sayıları da artmaya başladı. Breschi ve Cusmano (2004), Barber ve diğerleri (2006), Roediger-Schulga ve Dachs (2006), Cabo (1999), Roediger-Schulga ve Barber (2008) ile Ortega ve Aguillo (2010) bu çalışmalardan birkaçıdır. Küçük dünya kavramı (yüksek kümeleme ve kısa ortalama ilişkisel mesafelerde) çerçevesinde yapılan çalışmaların çoğunda ağ ortakları arasında mükemmel bir bilgi akışı varsayımı yapılmakla beraber gerçekte durum böyle değildir. Ayrıca, AB programları kapsamındaki odaklı çalışmalar uluslarüstü düzeyde yürütülen işbirlikleri olup, kurgusu gereği yenilik sisteminde yerel aktörler arasında bilgi akışının ne şekilde vuku bulduğu konusunu çoğunlukla cevapsız bırakmaktadır. AB düzeyinde yapılmış çalışmalar yoğunlukla ağların çekirdek kısmına odaklanmakta, ağın merkezinde yer almayan ortaklara olan dışsallık yeterince irdelenmemektedir.

Çerçeve Programı ağlarına ilişkin güncel çalışmalar daha çok ağın yapısına odaklanırken farklı partnerlerin gelecekteki performansına ilişkin öngörülere

pek rastlanmamaktadır. Çok bilinen açının dışında, daha az bağlı hücrelerin perspektifinden bakan yeni çalışmalar ağ yapılara ilişkin ezber bozan bir hüviyet kazanabilir. Bu tür bir yaklaşım uluslararası işbirliği çıktılarının linear olmadığı konusunda bazı kanıtlar sunabilir. Benzer şekilde uluslararası işbirliklerinin yerel dinamikleri konusunda da fikirler edinebiliriz.

Dolayısıyla uluslararası işbirliklerin yerel etkilerini ölçebilmek için ayrı bir odaklanma ihtiyacı vardır. Güncel literatüre yerel bilgi kapasitesinin artmasında hem yerel hem de uluslararası ağlara bağlı olmanın önemine vurgu yapmaktadır (Lall, 2001; Marin ve Bell, 2006; Narula ve Duning, 2000; Barnard ve diğerleri, 2012). Ülkemizde özellikle 6.Çerçeve Programına katılım ve akabinde ulusal düzeyde sağlanan uluslararası işbirliğini artırıcı Ar-Ge fonlarının büyümesi ile beraber birçok BİT araştırmacısı uluslararası işbirliği projelerine dahil oldu. Ancak bu projelerden elde edilen kazanımlar araştırmaya açık bir konudur. Olaya sadece bir proje ağına katılmak olarak bakmak yerine, araştırmacıların uluslararası projelere girmek veya ulusal projelerde yer almak arasında nasıl bir seçim yaptıkları veya ulusal ve uluslararası projelerden oluşan işbirliği karmasını ne şekilde oluşturduklarına ilişkin daha çok bilgi ve analize ihtiyaç vardır. Bu kavramları küresel hatlar-yerel hareketlilik kurgusu altında irdelemek mümkündür. Zira bu yaklaşım hem ulusal hem de uluslararası bağlantıları bir arada yürütmenin önemine de vurgu yapmaktadır (Maskell ve diğerleri, 2006). Bu yaklaşım yerel etkileşim ve küresel entegrasyon yönündeki adımların dinamik bir öğrenme sürecini tetiklediğini ifade etmektedir. (Bathelt, 2007).

Ulusları işbirliklerin elde edilen kazanımları daha tutarlı bir şekilde ele alabilmek için araştırmacı dinamiklerini ve yoğunluğu yüksek proje portfolyolarını tetikleyen unsurlara ilişkin daha çok bilgiye ihtiyaç vardır. Zira, bu tür araştırmaları sadece sayısal bazda yürütmek yeterli olmamakla beraber, derinlemesine analizlere ihtiyaç bulunmaktadır. Bu noktada yerel ve uluslararası arasındaki potansiyel sinerjinin çerçevesini belirlemek için hem derinlemesine analizler hem de odak grubu toplantıları yapılmıştır. Doğal

olarak kalitatif değerlendirmeler sistemik sorunlara işaret ederken, ne tip politikaların inşa edilebileceği konusunda da sahadan kanıtlar sunmaktadır.

Bu çalışma aynı zamanda yerel ve uluslararası işbirliği projelerine katılımların araştırmacıların belli parametreler etrafındaki çıktıları ile istatistiksel olarak anlamlı bir ilişki olmadığı konusunda da kanıtlar sunmaktadır. Bu noktada üniversitelerde görev yapan BİT akademisyenleri bağlamında çıkarımlar yapmak mümkündür. Bunu yapabilmek için de başlangıç olarak yerel-küresel bağlantıları ele alacak, aynı zamanda bu iki düzleme ilişkin analiz yapmamıza olanak verecek bir kavramsal çerçeveye ihtiyaç bulunmaktadır. Zaten, Wagner ve diğerleri, 2004; Lall, 2001; Marin ve Bell, 2006; Narula ve Dunning, 2000 gibi çalışmalar gelişmekte olan ülkelerin bilgi tabanlarını geliştirmelerinin bir bakıma hem yerel hem de küresel olarak entegre ağların etkisinin olduğunu ortaya koymaktadır. Dolayısıyla tez kapsamında küresel ve yerel anlamda dengeli bir yaklaşım benimsenerek, her iki düzlemdeki etkileşimlerin sürdürülebilirliliğinin sağlanması araştırmacı düzeyinde en uygun bir durum olarak kabul edilmektedir.

Bu çalışmada belirlenen bir zaman aralığında uluslararası işbirliği faaliyeti yürütmüş BİT araştırmacıları dört gruba bölümlendirilerek analiz edilmektedir. Bunu yaparken araştırmacılar, ulusal ve uluslararası proje portfolyoları, araştırma süreçlerine ilişkin mekanizmalara katkı sağlamak, bilimsel makale çıktıları ve özel sektörün kapasite gelişimine katkı yapmak olarak ifade edebileceğimiz beş boyutta performans analizine tabii tutulmaktadır.

Genel olarak benzer özelliklere sahip araştırmacıların proje portfolyolarında, yani yürüttükleri veya katkı sağladıkları proje birikimlerinden farklılıklar olduğunu söylemek mümkündür. Zira, uluslararası proje faaliyetlerine katkı ve katılım sağlayan BİT araştırmacıları, araştırma fonlarına erişimde sıkıntı çekilmediği durumlarda ulusal yönde mi yoksa uluslararası yönde mi derinleşeceklerine kendileri karar verebilirler. Bu noktada Barnard ve diğerleri 2012'a göre en ideal durum hem küresel hem de yerel bağlantıları bir arada

yürütülebilen araştırmacılar ortaya koymaktadır. Bunları kurgularken bazı araştırmacıların performanslarında da emeklilik, başka disiplinlere kayma, özel girişim kurma vb sebeplerle düşüşler olabileceğini de not etmekte yarar vardır. Bütün bu hususları dikkate alarak Graf (2011) çerçevesinde dört farklı grup kurgulanmıştır.

Bu dört gruba ilişkin karşılaştırmalı analizler yapılmakla beraber, özellikle derinlemesine analizlerde ulusal ve de uluslararası düzlemlerde ICT alanında en başarılı üniversitelerimizin başarı faktörlerine ilişkin kavramsal çerçeve oluşturmaya yönelik sorular sorulmaktadır. Başarılı üniversitelerimizin durumunu analiz etmek ülke koşulları dikkate alınarak BİT sektöründeki araştırmacılarımızın nasıl daha üretken olabileceklerine ilişkin gereken ideal koşullara ilişkin de çıkarımlar yapılmaktadır. Doğal olarak bu çıkarımlar niceleyici ve de niteleyici araştırma sonuçlarının bütüncül bir şekilde ele alınmasıyla daha anlamlı hale gelmektedir.

Öte yandan böyle bir çalışmanın verimli bir şekilde yürütülmesi için farklı veri tabanları arasında uyumluluğun sağlanması son derece önemlidir. Zira bu çalışmada da TÜBİTAK Başkanlık (ARDEB ve TEYDEB), AB Komisyonu, ULAKBİM gibi farklı kurumların veri tabanlarındaki verilerin eşleştirilmesi gerekmektedir. Bununla beraber araştırmacıların yararlanabilecekleri mekanizmaları önem derecelerine göre değerlendirecek bir sistem mevcut değildir. Bir başka ifade ile örneğin Çerçeve Programı, kariyer ve 1001 projeleri arasında önceliklendirmenin nasıl yapılabileceği konusunda bir yapıya ihtiyaç vardır. Bu eksikliği giderebilmek için oluşturulan odak grubu vasıtasıyla hali hazırda başvuru yapılabilecek farklı proje mekanizmalarına ilişkin ağırlıklandırma çalışması yürütülmüştür.

Bu çalışmanın temel analiz birimi ülkemizdeki BİT araştırmacıları olup, üniversiteler de araştırmalara akademik Ar-Ge için gerekli ortamı sağlayan mecra olarak ele alınmaktadır. Bu çerçevede araştırmacıların yerel veya

uluslararası işbirliği portfolyolarına ilişkin farklı kombinasyonları karşılaştıran değerlendirmeler yapılmakta olup, belli bir zaman aralığındaki proje portfolyo karmasının araştırmacıların gelecek performansı ile ilişkisi arasında da analizler yapılmaktadır. Elde ettiğimiz bulgular yerel dinamizm-küresel bağlantılar ilişkisinin akademisyenler ve üniversite düzeyinde açıklamalar sunmaktadır. Bahsi geçen bulgular farklı grupların ulusal-uluslararası proje yoğunlukları, bilimsel makale çıktıları, araştırmacıların proje karar süreçlerine ve de özel sektör Ar-Ge kapasite gelişimine katkı düzeyinde yapılan değerlendirme ve testler çerçevesinde elde edilmektedir.

Bu araştırmanın hazırlık safhasından itibaren Türkiye'deki araştırma sistemine ve güncel dinamiklere ilişkin derin deneyimi olan uzmanlarla ve işbirliği konusunda dünya çapında teorik ve ampirik çalışmalara imza atmış uzmanlarla birçok yüz yüze görüşme yapılmıştır. Bu noktada TÜBİTAK'ın akademi ve sanayiye ilişkin fonlama mekanizmalarını yürüten yetkililer, TÜBİTAK'ta Bilim Kurulu üyeliği yapmış olan akademisyenler, TÜBİTAK'ın üst düzey yöneticileri, rektör yardımcıları yüz yüze görüşmeler yapılmış olup, uluslararası düzeyde bilinirliliğe sahip Franco Malerba ve Caroline Wagner'den de geri bildirimler alınmıştır.

Daha sistemli olarak da uzman grubu oluşturulmuş, aynı zamanda özel bir odak grubu toplantısı gerçekleştirilmiştir. Özel odak grubu toplantısı TÜBİTAK'ın Elektrik, Elektronik ve Enformatik Araştırma Grubu'nun yürütme kurulu üyeleri ile yapılmıştır.

Bu çalışma 2003-2006 yılları arasında en az bir uluslararası projede işbirliğinde bulunan BİT alanındaki 79 Türk araştırmacıya dayanmaktadır. Bu araştırmacılar çalışmanın hedef kitlesini oluşturmaktadır. Hedef kitle, hakkında birşeyler öğrenmek istediğimiz nesnelerin (örneğin araştırmacılar) tamamının toplanmasıdır ve hedef kitlenin seçimi verilerden çıkan istatistikleri etkilememelidir (Lohr, 2010). Fakat BİT alanındaki araştırmacıları tespit

etmek kolay bir iş değildir çünkü Türkiye'de BİT alanındaki araştırmacılar için basit bir tanımlama bulunmamaktadır. Bazıları onları üniversitelerin Bilgisayar Mühendisliği Bölümü akademisyenleri diye tanımlarken, diğerleri bu tanımlamaya Elektrik Elektronik Bölümü akademisyenlerini de eklemektedir. Başka bir tanımlama da özel sektördeki ve kamu araştırma merkezlerindeki BİT alanındaki kişileri de dahil eder. Bizim çalışmamızda ise BİT alanındaki araştırmacılar TÜBİTAK Elektrik, Elektronik ve Enformatik Araştırma Grubu'ndan akademik destek alan ya da 6. ÇP'de fonlanan IST projelerine katılan kişiler olarak tanımlanmıştır. Bu sebeple, BİT alanındaki Türk araştırmacıların 2003 yılından başlayan ve 2006 yılında biten 4 yıllık bir periyot boyunca proje verileri kullanılmıştır.

Ayrıca, uluslararası işbirliğinden ne anladığımızı tanımlamamız da çok önemlidir. Öncelikle, burada ulusal sınırları aşan projeye dayalı işbirliğini kastediyoruz. Bu çalışmada uluslararası proje bazlı faaliyetler 6. ÇP'de fonlanan projelere ya da TÜBİTAK tarafından fonlanan uluslararası işbirliği projelerine dahil olmak diye tanımlanmaktadır. TÜBİTAK tarafından fonlanan uluslararası projeler COST projeleri ya da iki ülkenin araştırmacıları arasındaki ikili işbirliği projeleri olabilir.

Küresel hatlar-yerel hareketlilik literatürü (Bathelt ve diğerleri, 2004; Maskell ve diğerleri, 2006; Gertler ve Levitte, 2005; Moodysson, 2008; Trippl ve diğerleri, 2009, Grabher ve Ibert, 2013) doğrultusunda popülasyonu oluşturan etmenlerin heterojen özellikler göstermesi beklenmektedir. Bazı araştırmacılar geniş uluslararası faaliyetlere sahipken bazıları yerel çalışmalara odaklanmış ve diğerleri de küresellik yerellik dinamizminde dengede kalmışlardır. Bu da iki grup aktör arasında aracı pozisyonda bulunan etmenlerin bilgi tutucu diye adlandırıldığı sosyal ağlar literatürü ile paralellik göstermektedir (Gould ve Fernandez, 1989; Howe ve diğerleri., 2004; Graf ve Krüger, 2009, Graf, 2011, Foster ve diğerleri, 2011). Beklentimize göre bu iki grup sırasıyla iç ve dış odaklı aktörlerdir (Graf,

2011). Ayrıca, bazı etmenlerin uluslararası işbirliği yapan araştırmacılar ya da ulusal düzeyde aktif olan araştırmacılara göre proje sayısı bakımından ortalamanın altında performans göstermesini bekliyoruz. Böyle bir bölmeye dayanarak farklı gruplara ait araştırmacıların belirli bir zaman aralığında farklı bilimsel çıktılara ya da performansa sahip olduğu iddia edilir.

Literatürdeki (Graf, 2011; Dubois ve diğerleri, 2012; Akçomak ve diğerleri, 2013) örneklere dayanarak araştırmacılar küresel ya da yerel yönelimlerindeki çeşitliliğin derecesine göre 4 alt gruba ayrılabilir. Taksonomi 4 alt gruptan oluşturulmuştur. Ya da popülasyondaki her araştırmacının bu 4 gruptan biri ile bağlantısının yapıldığı 2X2'lik bir matris oluşturuldu da denilebilir.

2003-2013 yıllarını kapsayan ve araştırmacı ile üniversite seviyesinde üç farklı kaynaktan alınan beş farklı veri setinin eşlenmesi sonucu özel bir veri seti oluşturulmuştur.

- Yayın verisi ULAKBİM'den elde edildi.
- Akademik proje portfolyosu TÜBİTAK ARDEB'den elde edildi.
- Değerlendirici veri setleri TÜBİTAK TEYDEB ve TÜBİTAK ARDEB'den elde edildi.
- Doktora ve yurt dışı iş deneyimi verisi ARBİS'ten elde edildi.
- 6. ÇP ve 7. ÇP proje portfolyoları TÜBİTAK Ulusal Koordinasyon Ofisi aracılığıyla Avrupa Komisyonundan elde edildi.

Bu tarz kapsamlı bir veri seti belirli bir zaman aralığındaki BİT alanındaki araştırmacıların ve üniversitelerin bilimsel çıktıları bakımından ayrıntılı bilgi sağlamakta ve kıyaslanmasına fırsat vermektedir.

Türk araştırmacılar için proje seviyesinde farklı mekanizmalar bulunmaktadır. Bunların bazıları uluslararası işbirliğini güçlendirir, diğerleri ise ülke seviyesinde odaklanmıştır. Alan uzmanlarıyla ve araştırmacılarla

yapılan bir kaç tartışma sırasında farklı mekanizmaların bilimsel prestij, zaman, zorluk derecesi vb bakımından farklı ağırlıklara sahip olduğu hatırlatıldı.

Bilgi tutucular: Ortalamanın üzerinde uluslararası işbirliği yaparlar ve aynı zamanda en az bir ulusal çapta proje yürütürler.

Dışarıya odaklanmış araştırmacılar: 2003-2006 yılları arasında tamamen uluslararasına odaklanırlar. Sadece uluslararası projelere sahip olsalar da, ulusal ve uluslararası proje yoğunlukları bilgi tutuculardan daha azdır.

Aktif olmayan araştırmacılar: Araştırmacıların büyük bir çoğunluğu bu gruba düşmektedir. Onlar genellikle projelerin yürütücüleri olmaktansa fonlanan projelere katkı sağlarlar. Ağırlıkları her iki eksenin ortalama değerinin de altındadır.

İçeriye odaklanmış araştırmacılar: Uluslararası projeler yaparlar ancak 2003-2006 yıllarında genellikle içeriye odaklanan araştırmacılardır.

Taksonomi kurulmasından ve popülasyonun örneklemlenmesinden sonra aynı popülasyonun küresel ve yerel performansı 2007-2013 yılları için aşağıdaki başlıklarda takip edildi.

- Her bir grubun ayrı ayrı uluslararası ve ulusal proje yoğunlukları
- Yayın çıktısı
- Ulusal yönetişim organları katılımı
- Özel sektördeki Ar-Ge kapasitesi geliştirilmesine katkı

Uluslararası araştırma projelerine katılan BİT alanındaki araştırmacıların yerel işbirliklerini tanımlayabilen göstergeleri seçmek için bilim, teknoloji ve yenilik (BTY) göstergeleri literatüründe (örneğin Freeman ve Soete, 2009;

Laranja ve Boavida, 2012; Becic, 2011) kapsamlı bir indikatör listeleri yer almaktadır. Bütün yapının geçerliliğini denetlemek üzere süreç içerisinde uzmanlarla bir dizi görüşme yapılmıştır. Ardından, odak grup toplantısından, TÜBİTAK'ın fonlama tarafındaki yöneticilerinin (Elektrik, Elektronik ve Enformatik Araştırma Destek Grubu Yürütme Komitesi Sekreteri, TÜBİTAK'taki Sosyal Bilimler Araştırma Destek Grubu'nda geniş bir tecrübeye sahip bir uzman ve bileşik indikatörler konusunda bir uzman) ikili görüşmelerinden ve saha uzmanlarından (BİT alanındaki akademisyenler ve yenilik politikası uygulayıcıları) gelen geribildirimlere göre bu liste etraflıca revize edilmiştir.

Buna ek olarak, veri tabanlarının birlikte çalışabilirliğinden kaynaklanan veri kısıtları ve zaman kısıtları bazı en çok atıf alan BTY politikası literatüründeki göstergelerin dahil edilmesine izin vermemiştir. Örneğin, TÜBİTAK veri tabanı ve Türk Patent Enstitüsü veri tabanı arasındaki eşleşme problemi nedeniyle patent verisini kullanmak mümkün olmamıştır. Benzer sebepler veri tabanını Türkiye'deki diğer mekanizmalarla (SANTEZ, KOSGEB, Kalkınma Ajansları ve TTGV programları gibi) genişletmeye engel olmuştur, çünkü veriyi bireysel düzeyde eşleştirmek mümkün değildir. Bunun yanında, zaman kısıtları verinin BİT araştırmacılarının ortak yazarlık dinamikleri için kullanımını bloke etmiştir. Ayrıca, TEYDEB veri tabanı fonlanan özel sektör projelerindeki BİT araştırmacıları tarafından sağlanan danışmanlık sayısının hesaplanmasına izin vermemiştir.

Burada, belirli bir süre içinde farklı grupların farklı araştırma çıktılarına sahip olduğu gösterilmiştir. Bu argüman 2007-2013 dönemi için temel göstergeler bazında test edilmiştir. Gruplar arasındaki farklılıklar ve benzerlikler iki örneklemli t-testi ile tespit edilmiştir.

Bu 4 grubun ortalamalarını ayrı ayrı kıyaslamak ve sonuçta hangi grubun farklı olduğunu anlamak için çoklu t-test analizi yapılmıştır. Geleneksel hipotez testlerinde bağımsız iki örneklemin ortalamalarını kıyaslamak için 3

farklı hipotez kurma yolu vardır. Bunlar tek taraflı t-test (sağ taraflı ve sol taraflı) ve çift taraflı t-testtir. Tek taraflı t-test sadece tek yöndeki aşırı etkiyi dikkate alırken, çift taraflı t-test her iki yöndeki etkiyi de dikkate alır. Burada test edilmeyen yöndeki etkiyi kaybetmemek ve her iki yöndeki toplam aşırı etkiyi görebilmek için tek taraflı t-test yerine çift taraflı t-test kullanmayı tercih edilmiştir. Bu sebeple, sıfır hipotezini iki grubun ortalamaları eşit, altenatif hipotezi de bu grupların ortalamaları farklı diye aşağıdaki haliyle test edilmiştir.

$H_0: \mu_1 = \mu_2$

$H_1: \mu_1 \neq \mu_2$

Daha önce de belirtildiği gibi bu çalışmada BİT alanındaki Türk araştırmacıların 6. ÇP ağına ve TÜBİTAK tarafından fonlanan diğer uluslararası işbirliği projelerine katılımı küresel hatların yerel hareketliliği güçlendirip güçlendirmediği sorusu göz önüne alınarak ayrıntılandırıldı. Başka bir deyişle, biz uluslararası işbirliği ve yerel dinamizm arasında anlamlı bir ilişki olup olmadığını inceliyoruz. Bir sonuca ulaşmak için 4. Bölümde kurduğumuz farklı gruplar üzerinde ampirik bir araştırma yapmamız gerekiyor. Türkiye'deki BİT alanındaki araştırmacıların iç ve dış ilişkilerinin dereceleri ile ilgili taksonomiye göre farklı grupların çıktılarını ayrıntılandırmak gerekiyor. Özellikle bilgi tutucular ve dışarıya odaklanmış araştırmacılar bu analizin temel ilgi alanındadır, çünkü uluslararası işbirlikleriyle meşgul olan araştırmacıların ülke çapındaki program ve çalışmalarla ilgilenip ilgilenmediklerini göstermemiz gerekmektedir. Ayrıca, diğer iki grubun yani içeriye odaklanmış ve aktif olmayan araştırmacıların geçmişe dönük kayıtları bu dört grup içinde karşılaştırmalar yapma imkanı sağlayacaktır. Bu yüzden, bu dört grubun ortalamarını ayrı ayrı karşılaştırmak için çoklu t-testleri yapılacaktır. Bu karşılaştırmalara dayanarak hangi grupların diğerlerinden farklı olduğu anlaşılabilecektir.

Bilgi tutucular, dışarıya odaklanmış araştırmacılar, içeriye odaklanmış araştırmacılar ve aktif olmayan araştırmacılar arasında karşılaştırmalar yapmak için kullanılan anahtar göstergeler aşağıdadır:

1. Ulusal yönetim organlarına katılım
2. Özel sektördeki Ar-Ge kapasite gelişimine katkı
3. Ulusal proje yoğunluğu
4. Uluslararası proje yoğunluğu
5. Yayın çıktısı

İlk üç gösterge doğrudan araştırmacının ulusal ekosistem içindeki aktiviteleri ile ilişkilidir. Biz, araştırmacıların uluslararası projelere katılımı ile yerel katkıları arasında anlamlı bir ilişki olup olmadığını bulmayı araştırdık.

Nicel kısımda ICT araştırmacılarının proje performanslarıının heterojen olduğu gösterildi. Bu yüzden onlar yerel ve uluslararası projelerin kombinasyonu olarak dört grupta sınıflandırıldı. Ayrıca, her iki seviyede birden yoğun olan araştırmacıların birkaç üniversitede konstantre olduğu gösterildi.

Sayısal çalışmanın bulguları her iki yönde de etkin olan araştırmacıların popülasyonun en başarılı bilim insanları olduklarını ortaya koyuyor. Bulgular ayrıca. AB Ar-Ge ağlarının çevresinde olan bir ülkenin uluslararası ortakları güçlü olan araştırmacıların yerel araştırma tabanına önemli ölçüde katkıda bulunduklarını ortaya koymaktadır. Bu uluslararası işbirliği yapan araştırmacıların çoğunun yerel olarak da aktif olduğu anlamına gelir. Ayrıca, sadece 2003-2006 döneminde ulusal düzeyde aktif olanların, 2007-2013 döneminde uluslararası faaliyetlerinin gelişmiş olduğu anlaşılmaktadır. Öte yandan, işbirliği ve değişim faaliyetlerinde ortalamanın altında rol üstlenen bazı katılımcıların potansiyelinin altında performans ortaya koydukları ve belli bir proje katılım ulaştıktan sonra durgun hale geldikleri ileri sürülmektedir.

Betimleyici istatistiklere bakıldığında BİT alanındaki uluslararası boyutu olan tüm fonlanan projelerin % 69'unu Türkiye'deki altı üniversitenin (ODTÜ, İTÜ,

Koç, Sabancı, Bilkent, Boğaziçi) yürüttüğü görülmektedir. Başlangıçta onların kümelenmiş olduğu görülse de bu üniversitelerin proje portföy yoğunlukları ulusal ve uluslararası düzeyde heterojendir.

Dolayısıyla, bu üniversiteler başarılı örnekler olarak sunulmasına rağmen bunlar arasında da temel heterojenlikler vardır. Bazıları uluslararası işbirliğine daha fazla adapte olurken, bazıları ise hala yerel odaklı, ancak bir şekilde Türkiye'de yükseköğrenim BİT proje kapasitesinin en büyük kısmını üretebilmişlerdir. Buna ek olarak, benzer performansa sahip araştırmacıların proje portföylerinin neden farklılaştığını anlamamız gerekmekte ve bu yüzden de araştırmacılar arasındaki bu tip çeşitliliklerle ilişkili olan sorun ve tutumları yakalamamız gerekmektedir. Nitel çalışma, nicel kısımdan gelen açık sorunlar da hesaba katılarak, üniversite düzeyindeki 6 vaka çalışmasına odaklı yarı-yapılandırılmış görüşmelere dayanmaktadır. Görüşmeler sırasında kapsanan temel konular aşağıda listelenmiştir:

- Araştırmacıların işe alınma politikası
- Araştırma projesi yapmak için motivasyon
- Araştırma yapma ya da yayın yapma arasındaki denge
- Ulusal ya da uluslararası işbirliğindeki denge
- Performansa dayalı değerlendirme sistemi
- Benzer geçmişe sahip araştırmacıların performanslarındaki farklılıkların sebebi

Her görüşmeden önce ilgili üniversite hakkındaki nicel bulgular gözden geçirilmiştir, ki bu da daha detaylı sorular sorulmasına zemin sağlamıştır. Örneğin, ODTÜ'de uluslararası BİT işbirliği performansındaki düşüş ek olarak sorgulanırken, Koç Üniversitesi'nde uluslararası işbirliğine daha yoğun odaklanmanın arkasındaki politikaları öğrenmek için uğraşılmalıdır.

Görüşme aşamasında ilk olarak araştırma politikasından sorumlu rektör yardımcılarına ulaşmaya çalışılmıştır. Ulaşılamadığında üniversite düzeyinde

araştırmaları koordine eden ilgili yöneticilere veya üniversitedeki BİT bölümlerinin dinamiklerini bilen üst düzey insanlara ulaşmaya çalışılmıştır. Ne mutlu ki 4 rektör yardımcısı, TÜBİTAK'ın politikalar dairesi ile irtibatta olan bir iletişim noktası ve üniversitesinin ICT bölümünün dinamiklerini ve tarihini çok iyi bilen bir üst düzey araştırmacı ile görüşme yapılmıştır. Görüşmeler telefon ile gerçekleştirilmiş ve başlangıç aşamasında üniversitelerinin durumuyla ilgili nicel kısmın ortaya koyduğu bilgiler kendilerine sunulmuştur.

Bu tezde gelişmekte olan bir ekonomide BİT alanında küresel hatlar-yerel hareketlilik taksonomisi önerilmiş ve bu taksonomi ampirik olarak incelemiştir. Bu bölümde, bireysel beceri ile kurumsal ve ulusal düzeyde uygulamaların üzerinde durulacağı çok düzeyli bir çerçeve dahil edilecektir. Burada, araştırmanın temel bulgularını gözden geçiriyor ve politika seçeneklerini üç düzeyde (mikro, mezo ve makro düzeyde) tartışıyoruz.

Politika önerileri araştırmacıların performans takibinin yapılmasına ihtiyaç olduğunu ifade etmektedir. Kronolojik veri analizi ile gelen deliller tek bedene uyan uyan yaklaşımlar yerine farklı aktörler arasında heterojenliği, farklı kariyer seviyelerini, ulusal öncelikleri, araştırma ekosistemin kapasite ihtiyaçlarını dikkate alan ve farklı aktörler arası sinerji oluşturmaya politikalara olan ihtiyacı ortaya koymaktadır.

Politika önerileri geliştirmenin amacı, yükseköğretim sektöründe BİT alanındaki bilgi tutucuları sayısını artırmak ve BİT ekosisteminin katma değerini geliştirmektir. Çalışma sonucu elde edilen bazı öneriler aşağıdaki gibi özetlenebilir:

- BİT araştırmacılarının proje performans yoğunlukları heterojendir. Ampirik araştırma, 2003-2006 yılları arasında uluslararası işbirliğinde bulunan BİT alanındaki Türk araştırmacılarının güncel ulusal ve uluslararası proje portfolyolarında önemli farklılıklar bulunduğunu

göstermektedir. Genel olarak, gözlemlenen farklılıklar yerel ve küresel odak derecelerini dikkate alan farklı kümelenmeler için farklılaşmış politika ihtiyacını önermektedir. Dolayısıyla, tüm politikaların tek bir biçimde belirlenmesi yerine profil çeşitliliğini dikkate alan bütünsel bir yaklaşım belirlenmelidir.

- Yetkililer ve politika yapıcılar sadece tek bir boyutta aktif olan (sadece içeride veya sadece dışarıda aktif olan) araştırmacı kümelenmelerinin farkında olmalılardır. Popülasyonun değişik segmentlerine odaklanan daha çok çalışma yapılmalıdır. Potansiyellerinin altında performans gerçekleştirenlerin potansiyellerini etkinleştirecek değişik yöntemler bulunmalıdır.

- Türkiye'deki uluslararası işbirlikleri için artan fonlamaya karşın BİT ile ilgilenen üniversite sayısı halen oldukça düşüktür.

- Avrupa Çerçeve Programlarındaki düşük seviye işbirlikleri üniversiteler tarafından geliştirilen uluslararasılaşma stratejileri ile ele alınmalı ve kamu otoriteleri tarafından performans bazlı olacak şekilde desteklenmelidir.

- Bilgi tutucuları sayısı artırılmalıdır. Böylelikle, uluslararası işbirliğini teşvik eden politikalar ülkenin bilgi birikimine katkıda bulunacaktır çünkü bilgi tutucuların yerel bazda da olumlu sonuçlar yarattığı görülmektedir. Bu tarz politikalar bilgi tutucuların projelere katılımlarını ulusal seviyede kısıtlamamalıdır. Aynı anda ikiden fazla ARDEB destekli projenin yönetilmesini yasaklayan kotaların kaldırmasının gerekliliği rektör yardımcıları tarafından sıkça belirtilmektedir çünkü aynı anda iki projeden fazla projenin içeresinde yer alabilecek kalifiye araştırmacılar bulunmaktadır.

- Uluslararası BİT işbirliğinde sadece altı üniversite aktiftir. Uluslararası aktif olan üniversite sayısı mevcut durumda aktif olan üniversitelerin uluslararası faaliyetlerde bulunma potansiyeli olan diğer üniversitelerle (sayısı en az altı olacak şekilde) eşleştirilmesiyle artırılabilir.

- Geçen on yılda devlet birçok araştırma merkezine ve merkezi araştırma laboratuvarına yatırım yapmıştır. Ancak, bu merkezlerin uluslararası performansı göz ardı edilebilecek düzeydedir. Araştırma merkezlerinin potansiyelini etkinleştirecek özel politikalara ihtiyaç duyulmaktadır.

- Proje bazlı destek mekanizmalarının sayısı son zamanlarda artmaktadır. Araştırmacıların hibe için başvurulabilmesine ve proje teklifi sunulabilmesine izin veren çeşitli araçlar bulunmaktadır. Araç çeşitliliğinin olmasının dolaşan bilgiyi artırdığı varsayılmaktadır. Fakat politika yapıcılarının değerli bilgiler elde edebileceği yönetim mekanizmaları yeterli değildir. Proje yürütücülerinden geri bildirim almak için daha fazla mekanizma geliştirilmelidir.

Derinlemesine yapılan röportajlar süresince paylaşılan tecrübelere dayanarak çeşitli öneriler ortaya çıkmıştır. Bu öneriler bireysel (mikro), kurumsal (mezo) ve sistemsel (makro) seviyelerde değerlendirilebilir.

Bu tez uluslararası işbirliği yapan BİT alanındaki araştırmacıların ulusal seviyede önemli yerel faaliyetlerinin olup olmadığını araştırmaktadır. Ar-Ge çalışmalarının tabiatı göz önünde bulundurulduğunda, analizimizin ikinci periyodu olan 2007-2011 yıllarında daha düşük büyüme oranları gözlenmesine rağmen Türkiye toplam Ar-Ge harcamalarını, yüksek öğretim Ar-Ge harcamalarını, tam zaman eşdeğer araştırmacı sayısını, bilimsel yayın sayısını ve PCT patent başvuru sayısını içeren bilim ve teknoloji alanında dikkat çekici bir ivme kazanmayı başarmıştır. Akademik araştırma için sağlanan devlet desteğindeki artış doğrultusunda BİT projelerinin arz ve

talebi de artış göstermiştir. BİT alanındaki uluslararası işbirliği dikkate alındığında on yıllık veri analizi sonucu Türkiye'nin ikili ve çoklu işbirliğine ve aynı zamanda 7. ÇP BİT programına önem kazandırmada çeşitli zorluklarla karşılaştığı görülmektedir. Altı üniversite haricinde, 2003-2013 yıllarında sadece 33 üniversite BİT alanında işbirliği yapmakta ve TÜBİTAK'ın toplam akademik Ar-Ge desteğinin %16'sını oluşturan üniversitelerin uluslararası işbirliği seviyesi oldukça düşüktür.

Bu koşullar altında bu tez uluslararası işbirliği yapan Türk araştırmacılara odaklanmaktadır. Bu araştırmacıların yerel odaklanmalarını test etmek için öncelikle BİT alanındaki araştırmacı profillerinin küreselleşmeye karşın yerelleşme dereceleri ve iki dönem için birbirine karşı haritalanmış bölgesel ve küresel proje portföyleri açısından karakterize edilmesi ihtiyacı duyulmaktadır. Popülasyonun küresel ve yerel performansı; uluslararası ve ulusal proje yoğunluğu, yayın çıktısı, ulusal yönetim birimlerine katılım ve özel sektördeki Ar-Ge kapasitesi gelişimine katkıyı kapsayan beş gösterge bazında takip edilmiştir. Sonuçların duruma bağlı olduğunu bulunmuştur. İki seviyede de oldukça başarılı olan bir araştırmacı grubu bulunmaktadır ve bu durum onların yerel hareketlilik yarattığı anlamına gelmektedir. Diğer taraftan, yerel ve küresel olabilen ve verilen zaman aralığında sadece tek bir odağı olan iki ilave grup bulunmaktadır. Son grup herhangi iki boyutun ortalamasının üstünde bilimsel performans göstermeyen, aktif olmayan araştırmacılardan oluşmaktadır.

Türkiye'de BİT alanındaki bir araştırmacının uluslararası ve ulusal dinamiklerini haritalandıran bir çerçevenin oluşturulması sonrasında araştırmacının her iki boyutta da daha iyi performans göstermesinin araştırmacının ait olduğu üniversite tarafından sağlanan araştırma ortamı ve doktora sonrası deniz aşırı iş tecrübesi ile ilişkili olduğu bulunmuştur. Bu tarz kısıtlı bulgular Türkiye'deki BİT araştırma dinamiklerini çözmek için daha fazla analizlerin yapılmasının gerektiğini göstermektedir. Bu amaca dayanarak Türkiye'de BİT alanında en başarılı 6 üniversitenin üst düzey

temsilcileri ile derinlemesine röportajlar gerçekleştirilmiştir. Yapılan bu derinlemesine röportajlar farklı araştırmacı profillerine göre farklılaştırılmış politika araçlarının ve aynı zamanda üniversite düzeyinde uluslararasılaşma stratejisinin gerekliliğine dikkat çekmiştir. Türk BİT alanı altı üniversite dışında uluslararası düzeyde bağlantılı olmadığı için her iki aksiyon da kritik öneme sahiptir.

Bu çalışma Türkiye'deki durumu sunmaktadır ve yerel-küresel işbirliği dinamiklerini araştırmacı düzeyinde belirlemek için taksonomi önermektedir. Bu taksonomiyi BRICS ve EU12 ülkelerinde de test etmek ve ülke bazlı karşılaştırmaların gerçekleştirilebileceği bir alan yaratmak oldukça verimli olacaktır.

Türkiye'deki araştırma ve yenilik ekosisteminde farklı sektörler için de benzer alanlar ortaya çıkarılabilir. Benzer çalışmaların Ulusal Bilim, Teknoloji ve Yenilik Stratejisi 2011-2016'da (UBTYS 2011-2016) belirtilen diğer öncellikli alanlar için de uygulanması önerilmektedir.

Benzer altyapılı araştırmacıların araştırma portföylerindeki ana ve belirleyici olan farklılıklarını açıklayan daha fazla incelemelerin olması kanıta dayalı politikaların geliştirilmesine katkıda bulunacaktır.

Yukarıda belirtilen kanıt doğrultusunda, en iyi performans gösteren araştırmacılarca kurulan yerel-küresel bağlantıların etkisinin araştırılması için daha fazla analizlerin yapılması kanıta dayalı politikaların test edilmesine yardımcı olacaktır.

Popülasyonumuzdaki Türk BİT araştırmacılarının çoğu Amerika Birleşik Devletleri'ndeki üniversitelerden doktora derecesi aldığından, benzer bir çalışmanın Amerika-Türkiye işbirliği bağlantılarının dinamiklerini araştırmak için yapılması merak uyandırıcı olacaktır.

APPENDIX D: CURRICULUM VITAE

Hüseyin Güler is a professional with 12 years of experience in ICT, automotive industry, government and international relations.

Recently, he is mainly focused on development of policy tools for innovation oriented entrepreneurial ecosystem including triggering innovation and entrepreneurship in universities and boosting R&D intensive start-ups.

Mr. Güler coordinated several studies to identify priority research topics in strategic sectors like automotive, ICT, energy and food. Developed a model to monitor and assess the progress of different actors of innovation ecosystem including public funded research centres.

He also lead the preparatory work and the launching process of new national STI strategy namely the National Science Technology and Innovation Strategy 2011–2016 including the relations with all level stakeholders.

He is experienced in building and executing business models in uncertain and complex cases, policy and strategy development, dynamics of innovation systems, analysing knowledge flows between advanced countries and emerging economies, conducting relations with international governance bodies including European Commission, OECD, World Bank and UNCTAD and managing multicultural and multidisciplinary teams.

Mr. Güler joined to TÜBİTAK in June 2004. He served as the National Coordinator of Turkey for EU Framework Programmes (2006–2009). He took a leading role during the accession process of Turkey to FP7 including the negotiations with the European Commission; initiated and managed campaigns to increase the awareness on FP7 in Turkey, coordinated the mapping studies of Turkish research potential in ICT, production

technologies, nanotechnology and material sciences; developed strategies to link Turkish research diaspora and national landscape. He introduced networking actions to promote Turkish R&D potential across EU including Turkish R&D Day at European Parliament, networking events on ICT and Nanotechnology in Brussels (2006–2009).

He was a member of the Turkish Delegation during the screening process between the Government of Turkey and the EU Commission, within the scope of the Science and Research Chapter. He defined the FP7 ecosystem in Turkey and collaborated with associations like TOBB, TUSIAD, Istanbul Sanayi Odası, Türkiye Bilişim Vakfı, and Türkiye Bilişim Derneği in order to increase the Turkish involvement in European R&D Programmes (2005–2006). While he was the responsible for the reorganisation of TURBO-ppp (A Brussels-based Turkish R&D Liaison Office)**,** he developed a business model to enhance the links between TURBO-ppp, its founders, European Commission and Turkish Research Area in order to increase Office's added value (2004–2005).

He represents Turkey in international meetings including OECD CSTP, OECD TIP, ERAC, EU Commission’s Joint Research Centre Board of Governors, DG INFSO ICT Research Directors and taking part in the university and industry oriented national events as trainer or speaker. Since September 2011 he serves as Acting Head of the STI Policy Department at TÜBİTAK, while since May 2009 he has been holding the position of Head of Unit in the same department.

Prior to joining TÜBİTAK, Mr. Güler worked in the ICT and automotive sectors in Turkey. He started his professional life at TURKCELL (a leading GSM operator of Turkey), where he developed TURKCELL’s first contractual subscription application in 2002 that aimed to increase the loyalty of the most valuable customers. He undertook the responsibility of new product development studies with suppliers of several face-lifting FIAT Doblo projects

in TOFAŞ (a leading light commercial vehicle producer of Turkey). He also had the responsibility of coordination of the R&D phase for the project oriented to the Middle Eastern market.

He graduated from Marmara University, Department of Industrial Engineering, and holds MBA degrees from Uludağ University and Kavrakoğlu Management Institute.

APPENDIX E: TEZ FOTOKOPİSİ İZİN FORMU

ENSTİTÜ

Fen Bilimleri Enstitüsü ☐

Sosyal Bilimler Enstitüsü ☐

Uygulamalı Matematik Enstitüsü ☐

Enformatik Enstitüsü ☐

Deniz Bilimleri Enstitüsü ☐

YAZARIN

Soyadı : GÜLER
Adı : HÜSEYİN
Bölümü : BİLİM VE TEKNOLOJİ POLİTİKASI ÇALIŞMALARI

TEZİN ADI (İngilizce) :
DOES PARTICIPATION IN INTERNATIONAL R&D NETWORKS ENHANCE LOCAL DYNAMISM? RESEARCHER LEVEL ASPECTS FROM TURKEY

TEZİN TÜRÜ : Yüksek Lisans ☐ Doktora ☐

1. Tezimin tamamından kaynak gösterilmek şartıyla fotokopi alınabilir. ☐
2. Tezimin içindekiler sayfası, özet, indeks sayfalarından ve/veya bir bölümünden kaynak gösterilmek şartıyla fotokopi alınabilir. ☐
3. Tezimden bir bir (1) yıl süreyle fotokopi alınamaz. ☐

TEZİN KÜTÜPHANEYE TESLİM TARİHİ: