COOPERATION AND CLUSTER STRATEGIES WITHIN AND BETWEEN TECHNOLOGY-INTENSIVE ORGANISATIONS: HOW TO ENHANCE LINKAGES AMONG FIRMS IN THE TECHNO-PARKS

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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 Master of Science.

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ABSTRACT

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M.S., Science and Technology Policy Studies
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Focus of this thesis will be on the network and cluster strategies within and between technology-intensive organizations/firms and how to manage those networks in order to improve their outcome in the context of building or enhancing innovative advances, technological capabilities and/or competitiveness. World today is characterized by rapid transformations in all aspects of human's life where innovation, technological change and technological progress play the most significant role. Therefore, technology-intensive organizations by engaging in strategic alliances, clusters and networks tend to extract maximum benefits i.e. to enable entry into the international markets and to develop core competences. Even though clusters have become a highly popular strategy, many of them fail to realize their intended goals. Thus, this thesis will attempt to explore why choosing a clustering strategy can be beneficial, as well as to provide better understanding of such cooperation and requirements for success. Main focus will be on investigating if there are inter-firm and firm-university linkages among the actors located in a particular techno-park, and to diagnose if the close proximity contributed and eased development of the networks among the firms settled in the METU Techno-

park and Bilkent Cyber-park. Results of the analysis showed certain extent of firm-university relationships and low level of inter-firm interactions. This further implied necessity of the policy interventions for enhancement of those interactions if the studied techno-parks are to become successful in the sense of the theoretical techno-park model, and if the tenant firms are to extract maximum benefits associated with cluster concept in theory.

Key words: Clusters; Networks; Innovation; Techno-parks; Policy

ÖZ

TEKNOLOJI YOĞUN ORGANIZASYONLAR ARASINDAKI IŞBIRLIKLERI VE KÜMELENME STRATEJILERI: TEKNOPARKLARDAKI FIRMALAR ARASINDAKI ILIŞKILERIN GÜÇLENDIRILMESI

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Bu tezin odak noktası teknoloji yoğunluklu organizasyonların/firmaların ortaklık (ağ, şebeke) ve kümeleşme stratejileri ile bu şebekelerin yenilikçi ilerlemeler ve teknolojik rekabet açısından daha fazla ürün ve sonuç üretmek adına nasıl daha iyi idare edilebileceklerini araştırmaktır. Bugünün dünyasında insan, hayatının her bölümünde yenilikler, teknolojik değişimler ile karşılaşmaktadır. Doğal olarak teknoloji günümüz insanının yaşantısında çok önemli bir yere sahiptir. Dolayısıyla, teknoloji yoğunluklu organizasyonlar stratejik birleşmelerle, kümeleşmelerle ve şebekeleşmeyle verimliliklerini artırma çabasına girişmişlerdir. Bu sayede kabul edilebilir bir yeterlilik sağlamaya çalışılmakta ve uluslararası marketlere girişin kapısı aralanmaktadır. Öte yandan son zamanların popüler stratejisi olan şirket kümeleşmeleri ve birleşmeleri çoğunlukla, şirketlere önceden planlanan başarıları sağlamaktan uzak olmaktadır. Bu nedenlerle, bu tez kümeleşme stratejilerinin şirketler açısından nasıl yararlar sağlayacağını araştıracak ve başarı için gerekli olan unsurları ve gereklilikleri anlamamıza yardımcı olmaya çalışacaktır. Bu tez ayrıca belli başlı bir kümeleşme oluşumu içinde yer alan bazı şirketlerin resmi ve gayri resmi bağlarını da inceleyecektir. Bununla ilgili olarak ODTÜ Teknokent ve Bilkent CyberPark gibi teknoparkların,

bünyesinde bulunan firmalar arası bağlara katkıları da araştırılacaktır. Araştırma sonuçlarının gösterdiği kadarıyla, firmalar ile üniversiteler arasında belli bir etkileşim saptanmıştır. Bununla birlikte, firmalar arası etkileşimlerin çok zayıf kaldığı tespit edilmiştir. Bu bulguların ışığında, incelenen teknoparklarda istenilen başarı seviyesine ulaşılması ve bu teknoparkların bünyesinde barındırdığı firmaların kümeleşmeden maksimum şekilde faydalanabilmesi için bahsi geçen etkileşimlerin iyileştirilmesine yönelik tedbirler alınması gereklidir.

Anahtar kelimeler:
Kümeleşmeler; Ağlar; İnovasyon; Tekno-Parklar; Politikalar

То Хулуси

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CHAPTER 1

INTRODUCTION

Concepts of technology, knowledge and innovation play huge importance in today's theoretical and practical world. Their importance in every aspect of human's life is evident from the beginning of the civilization. Understanding these concepts is crucial in order to understand new collaborative strategies for the firms that struggle to survive in rapidly changing environment that created global markets and global economy. In present, creation of technological innovation, its diffusion and adoption are being central to the economic development.

Rapid transformations are essential characteristic of today's world where innovation, technological change and technological progress play the most significant roles. Technology development is considered as one of the major forces that facilitate change in the contemporary business environment. Rapid technological change forces producers to constantly upgrade their process technologies and introduce new products (Lall, 2003: 3). Simply put, technology is a dynamic process that changes continuously and innovation is a complex, social activity. Hence, technological innovation is not an isolated instance (Castells, 1996: 37). For a new technique and/or product to be implemented, company has to interact with its environment that is comprised of competitors, partners, universities, research centres, suppliers, public authorities, and so forth. Innovation itself is becoming more costly and often more risky than before and there is now greater inter-firm collaboration and networking in innovative effort (Lall, 2003: 3). Intensifying competition, pace and direction of technical change has increased the importance of learning and therefore the need for co-operation amongst firms and between business and knowledge institutions (Wilkinson and Moore, 2000: 233).

The dynamics of the competition are shifted to the global scale due to the rapid development and diffusion of the new technologies, remarkably, information and communication technologies. In order to survive in such an increasingly competitive environment and markets, firms, organizations, governments and countries in

general, must adjust and adapt themselves to the changes. Firms have to follow the technology trends and adopt their businesses to the high-tech environmental challenges if they are to become competitive and sustain their superior performance. The most successful ones will be the leaders of technological change and innovation, while the others will remain followers or even losers whose survival is threatened by competition and changing technology.

From the 1970s, vast amount of literature and academic studies was directed towards the concept of regional clusters of technology-intensive firms. Recent studies exert the need of creating new policies that will lead not just to business success but regional, national and global as well. Majority of scholars realized this importance and directed their studies towards the examination of inter-firm linkages in the shape of strategies such as clustering, networking and other forms of joint-ventures. Vast amount of theoretical literature points out reasons and outcomes of the collaborative strategies from different perspectives. The overall aim is directed towards conceiving policies that would advance or ease individual or regional innovative and technological capabilities in the new stage of globally shaped economy that accentuates technology as the key to high performance.

This thesis will hence take into consideration the main aspects of the innovation, knowledge and learning in order to provide better understanding of the contemporary trend towards the cooperative strategies in the highly competitive environment. Particular features of clustering and networking will be further discussed with emphasis on benefits of such linkages and social relationships for technology-intensive firms. Lastly, in the scope of theoretical presentation, techno-parks will be discussed as entities consisting of technology-intensive firms with potential of having clustering and networking advantages. The empirical part of the thesis encompasses field study in the two most popular techno-parks in Ankara.

1.1. PURPOSE, SCOPE AND STRUCTURE OF THE THESIS

The main purpose of this thesis is to examine concepts of clusters and networks, and concept of the techno-parks in order to provide the framework which support attitude that these strategies can be highly beneficial for technology-intensive firms

that operate in the high-tech environment; and to investigate if there are linkages among the firms in observed techno-parks, and according to obtained results to propose adequate policy.

Accordingly, theoretical concepts of innovation, knowledge and learning, as well as comparative review of clusters, networks and social relationships will be explored. The expected outcome of this analysis is to emphasize that clustering and networking strategies are being beneficial for both technological development and innovation on one side, and for firms that are choosing clustering on the other side. The literature review will be completed by providing overview of the techno-park concept, its characteristics, advantages, and success factors. The outcome of this discussion will emphasize that firms located in techno-parks are in the category of technology-intensive organizations, they may form robust inter-firm and firm-university ties, and thus techno-parks offer potential for and advantages of clustering and networking.

These discussions are perceived as boundaries of the literature survey as they are the most relevant for the theme of the thesis.

Literature review will then present the framework for the field study of the thesis. Purpose of the field study is to explore whether there are linkages and co-operations among the firms inside the two largest techno-parks in Ankara: METU Techno-park and Bilkent Cyber-park. If majority of tenant firms has developed inter-firms networks (e.g. developed on the basis of exchange of tangible and intangible resources, transfer of technology, joint marketing activities, joint projects, research and development (R&D), new product development (NPD), and so forth), we will seek to propose the policy of enhancing the inter-firms relationships. Nonetheless, it is expected that very small number of tight affiliation and other elements of the clustering and networking strategies, except geographical proximity, will be found in the observed techno-parks. In this scenario, we will attempt to propose policy that encompasses elements such as: observed techno-parks do have potential for becoming cluster and thus linkages among the firms should be fostered; raising the firms' awareness of clusters and networks is crucial for shifting their efforts towards the exploitation of clustering and networking benefits; and intensifying and

enhancing both formal and informal linkages among the actors that constitute the cluster is beneficial according to the theoretical discussions.

Our sample of the investigated firms is more than 20% of the total number of the firms settled in each techno-park. In order to prevent undesirable events (e.g. interviewees may not be willing to participate or may be uncomfortable about sharing all the issues intended to be asked in the questionnaire) the firms of which the main field of activity is related to defence sector in the METU Techno-park are excluded from this research. The field study is pursued in the small and medium sized companies rather than large ones. This is due the fact that majority of big companies in METU Techno-park belong to defence sector. In addition, networking and clustering are often emphasized in the literature as strategies that can enhance performance of small technology-intensive firms.

The structure of the thesis consists of five main chapters: introduction; literature review that encompasses three main sections about innovation, networks and clusters, and techno-parks; method of the field study; results of the field survey; and conclusion of what have been done in the entire thesis together with policy recommendations and suggestions for the future research. Each part will be illustrated in more details below.

This thesis will examine the basic features of innovation and learning in order to provide better understanding for the clustering and networking in today's business environment. In the first section of chapter two, certain aspects of the technology, innovation, knowledge and collective learning will be discussed. In turn, this will help in better understanding of the conditions that technology-related firms operate in and challenges that they encounter when managing their businesses.

In the most developed regions across the US and Europe, technology-intensive organizations by engaging in strategic alliances, clusters and networks tend to extract maximum benefits i.e. to enable entry into the international markets and to develop core competences. Even though clusters, alliances and networks have become a highly popular strategy, many of them fail to realize their intended goals. Hence, second section of chapter two reviews basic elements comprising the networks and clusters, as well as social relationships and motives that are important

for understanding clusters and networks. Furthermore, this section will attempt to explore why choosing clustering strategies can be beneficial for the technology-intensive firms and to provide better understanding of such cooperation and requirements for success. Special focus will be on the proximity, inter-firm networks and firm-university linkages in the cluster.

Third section of chapter two focuses on the formation and purpose of the Techno-parks as one form of clustering and regional networking. Techno-parks are the regions that host small, technology intensive firms which, by being settled in techno-park environment, are given opportunity to use benefits of being close to other similar or non-similar companies and knowledge centres i.e. university and its resources such as, human resources, research laboratories, libraries, etc. By definition, being settled in techno-park eases and gives opportunity to tenant firms to access resources of other firms and university; to develop trust and strong relationships among themselves; to assimilate tacit knowledge and useful information; to use benefits of collective learning; to develop strong region and constantly to progress. Moreover, governments promote favourable tax and credit incentives for the techno-park firms (e.g. tax on income, personnel, VAT, etc.). However, while there are extremely successful cases, this given opportunity is not easily put into the practice and there is vast amount of bust imitations and unsuccessful cases being found in various regions. By presenting some of the features of flourishing cases, this thesis will not try to settle a pattern that every techno-park should follow, but to point out what might be the benefits that firms can extract from being engaged in techno-parks as a small region with high potentials.

Chapter three focuses on the purpose of the field study in detail as well as method for data collection. Here, we explore if the close proximity and other opportunities given to the firms that are located in a techno-park contribute and ease development of the social relationships, collective learning, and whether networks among the firms settled in the METU and Bilkent techno-parks occur. The sample of firms was carefully chosen and amounts 21% of the total number of firms located in afore mentioned techno-parks.

Chapter four is designed to present results of the implemented field study. The results indicate whether the firms settled in the METU Techno-park and Bilkent Cyber-park have developed linkages, formal and/or informal, among themselves.

Chapter five is dedicated to the policy recommendations on how to foster development of networks among the techno-park's tenant firms, and conclusion of thesis. Understanding importance of the techno-park concept, as well as managing techno-parks, have growing importance in today's' economic and social life, and thus this study will contribute to this debate by providing policy recommendations that may enhance firms' performance on the one side, and development of the technology and region on the other side. This chapter also contains certain propositions with regard to possible future studies.

It is strongly believed that general issues that are the hub of this thesis will continue to have increasing impact on future realm of study and research in order to achieve the best possible practices.

1.2. EXPECTATIONS AND HYPOTHESIS

The expected outcome of the literature survey is the overview of the clustering and networking strategies with emphasis on the benefits they provide to the firms engaged in the cluster and/or network. The other important expected outcome is the overview of the techno-park concept. Here, the accent is on the assumption that techno-parks may ease development of the robust inter-firm, as well as firm-university linkages, and on the benefits that small technology-intensive firms inhabited inside the techno-park can obtain.

The hypotheses of the thesis are defined as follows:

1) *If small technology-intensive firms are settled in the techno-park as a particular form of cluster then due to the proximity to university these firms will employee high level of highly-qualified personnel that is highly mobile within a techno-park.*

In successful techno-parks and other types of innovative clusters highly qualified labour pool is crucial for the success of firms and growth of a cluster (Saxenian 1996, Keeble 2000). In techno-parks it is expected that technology-intensive tenant companies will have higher level of qualified workers due to the close proximity to university as an important source of such labour. Moreover, successful examples depict high level of mobility of workers among the tenant companies and frequent occurrence of spin-offs from existing companies. In theory, high level of mobility of workers and spin-offs implies intensive informal inter-firm networks and strong personal relationships. Highly qualified labour, mobility of workers and spin-offs further deepen knowledge and information exchange, and contribute to the development of local pool of knowledge and collective learning. In scenario 1, if we find out that there is high level of qualified workforce, labour mobility and spin-offs in METU and Bilkent techno-parks, policy recommendation will be directed towards raising the level of such labour. In scenario 2, if the opposite is true, we will seek to propose policy that will encourage and support employment of highly-qualified labour by tenant companies.

2) *If the technology-intensive firms are settled in the techno-park then there will be high level of firm-university alignment.*

In successful techno-park cases, the prominent level of inter-firm ties is evident. Hence, another central issue of the field study is to identify whether there are tight affiliations among the firms and university in METU and Bilkent techno-parks. In scenario 1, if there is certain extent of university-firm ties in the studied techno-parks we will seek to propose the policy for intensifying those relationships. In scenario 2, if there are no tight alignments, or if the level of university-firm ties is not significant, we will seek to propose policy for fostering co-operations among the university and firms.

3) *If the technology-intensive firms are settled in the techno-park then these firms will have high level of developed inter-firm linkages.*

Successful techno-park cases indicate the high level of inter-firm ties. Thus, the prime aim of the field study in this thesis is to detect if there are tight affiliations among the firms in the METU and Bilkent techno-parks. In scenario 1, if there are

intensive inter-firm networks in the studied techno-parks we will seek to propose the policy for intensifying those relationships. In scenario 2, if there are no intensive and dense networks among tenant companies, or if the inter-firm ties are weak, we will seek to propose policy for fostering such co-operations among the firms.

4) *If the technology-intensive firms are settled in the techno-park, and if they have tight inter-firm and firm-university affiliations, they can extract maximum benefits of the techno-park concept and of clustering and networking in general.*

In order to make use of advantages of the clustering and networking, firms need to develop co-operation among themselves. Being settled in the techno-park offers close proximity to other similar, non-similar firms, university, and university resources, and thus ease establishment of co-operation and trust. In scenario 1, if firms had built robust inter-firm and university-firm ties in the studied techno-parks, they can exploit benefits of clustering and networking, and we will seek to propose the policy for intensifying utilization of those benefits. In scenario 2, if there are no tight alignments, or if the level of co-operation between the firms, and firms and university is poor, we will seek to propose policy for raising awareness of the networking and clustering benefits for the technology-intensive firms settled in the techno-parks.

The expected outcome of the field study is to test validity of these hypotheses, and to help in shaping ideas for the policy recommendation.

CHAPTER 2

INNOVATION, NETWORKS, CLUSTERS AND TECHNO-PARK CONCEPTS

In recent years there is a growing popularity of the clustering and networking concepts. The environmental and economic changes brought necessity of new strategies for the firms, regions and nations. Consequently, a growing body of literature is directed towards the examination of industrial districts composed of small technology-intensive firms that struggle in the global competition. Emphasis is put on the co-operation and relationships among the various types of organizations. The collaborations between small and medium technology-intensive enterprises, as well as co-operation between them and other institutions, are comprehended as means for more effective competition on the local, regional and global scale. In regard to this, vast amount of researchers put their accent on the importance of innovation, technology and learning in today's global economy referred as knowledge-based economy. More specifically, careful analyses are directed towards the geographic dimension of innovative activities and its implications for clustering, particularly those clusters of small and medium-sized enterprises in technology-based or high-technology industries (Breschi and Malerba, 2005). Here, accent is on the fact that real sources of contemporary innovation are residing in neither the individual entrepreneur nor the research laboratories of large firms but in networks of social relationships between such organizations and others (Cooke, 2002).

The idea of the industrial districts and advantages of agglomeration dates back to century-old theory of Alfred Marshall in the 1890s. Emphasis in his work are on understanding the role of external economies, knowledge transfer, skills and learning among firms in geographical proximity (Cooke, 2002). Marshallian externalities are defined as cost advantages due to agglomeration, including availability of a pool of specialized workers; easy access to suppliers of varied and specialized inputs; and quick dissemination of new knowledge and ideas (Caniels and Romijn, 2001: 4). Thus, Marshall was one of the first to emphasize the positive effects of co-location of firms (Karlsson et al., 2003). From the Figure 1, it can be

seen that Marshall (1920) recognized the following: 1) The first reason for the firm to settle down in the cluster is ''presence of a labour pool with specialized skills''. This enables firm to achieve transaction cost savings while searching for qualified workforce. It is also advantageous for new firm entering the cluster as it lessens the start-up costs and barriers to entry. Besides, high mobility of employees in the cluster facilitates transfer of information between the firms located in that cluster; 2) The second reason, ''easy access to suppliers of varied and specialized inputs'', enable firm to lower the transaction costs and to achieve economies of scale and scope. This is most likely due to suppliers' proximity and hence, ability of firm to reduce transportation and communication costs. Moreover, there are diverse public and private service providers and institutions (e.g. university, research laboratories, etc.) available in the cluster's environment. This in turn offers heterogeneity of resources and competences to the firms settled in the cluster; 3) The third reason, ''technology spillovers'' or ''quick dissemination of new knowledge and ideas'', contributes to the knowledge spillovers. This means that firms will benefit from the new information or knowledge originated and diffused from the other firms in the cluster.

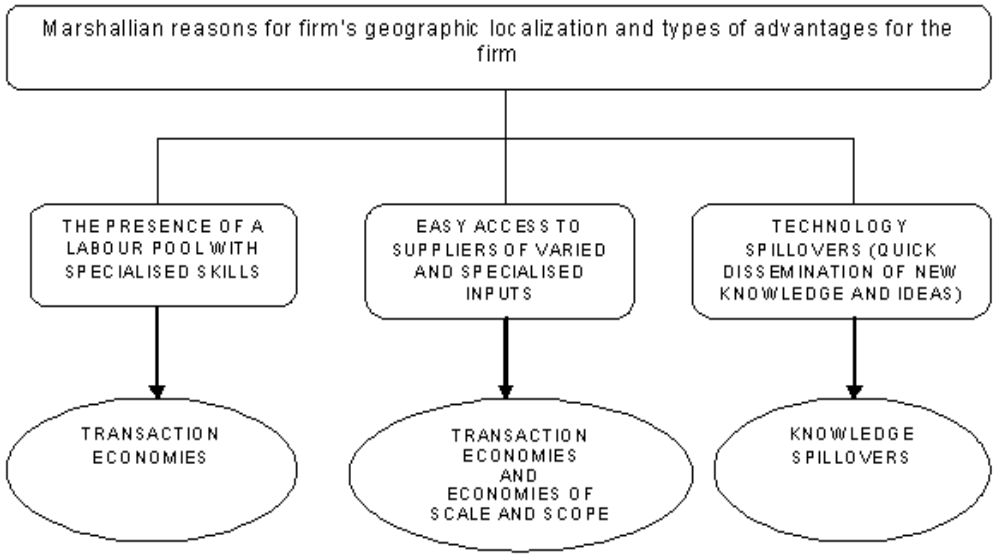

Figure 1. Reasons and Advantages of Agglomeration Economies in the Marshallian Framework (Marshall, 1920)

The ideas of Marshall have been further developed by the number of industrial and innovation economists. As a result of growing research and policy experiments, a number of different theoretical frameworks have been developed to analyse geographical dimension of innovation and its implications for clustering (Breschi and Malerba, 2005: 2). For the scope and purpose of this thesis, short discussion of the theoretical developments, summarized and presented by Breschi and Malerba (2005: 2-6) is listed below in Table 1:

Table 1. Summary of the theoretical frameworks

1)	Vast amount of literature and research has been developed around the notion of *localized knowledge spillovers* as the key explanatory factors for the clustering of innovative firms. Here, the transmission of innovative knowledge occurs more efficiently among closely related actors. Costs of knowledge transmission are lowered and knowledge is more effectively transmitted through interpersonal contacts and inter-firm mobility of workers, all of which are eased by close geographical and cultural proximity. Some of the overlooked points, examined by a number of different approaches, are other important factors and conditions that account for clustering of firms in technology-based or high-technology industries.
2)	Vast amount of the theoretical concepts developed within the realm of *economic geography* and *regional economics*. Some of the approaches encompass works on technological districts and new industrial spaces by Storper and Harrison in 1991 and Storper in 1992, innovative milieu by Maillat in 1991, Camagni in 1991, Capello in 1999, *proximite* by French school, mainly Rallet and Torre in 1999, the localized learning by Maskell and Malmberg in 1999, and numerous case studies about successful high-technology districts and clusters such as ones done by Saxenian in 1994. Major common elements underpinning these studies include: learning through networking and interactions as a reason for clustering and success of innovative clusters; learning through various relationships, formal and informal collaborations, inter-firm mobility of skilled workers and the spin-off of new firms from existing firms, universities, and public research centres; high level of embeddedness of local firms in a network of knowledge sharing which is supported by close social interactions and by trust, and which encourages informal relationships among actors; reducing costs and risks in the technology-intensive clusters by availability of common set of resources (such as, universities, public research centres, and pool of specialized and skill labour).
3)	Evolutionary theory added to these insights a focus on technology, knowledge, learning and capabilities. In the analysis of clusters evolutionary theory and capability approach added a focus on sector and their major differences in the innovation and production processes, where some of key drivers of agglomeration are sector-specific. Technological and organizational learning is differentiated by the cross-sectoral differences in agglomeration and it affects localized knowledge spillovers, inter-organizational learning, knowledge complementarities and localized labour mobility, innovative explorations through spin-offs, and the birth of new firms.

4)	Concept of *innovation systems*, another important concept among the research on clusters of innovation, considers innovation as an interactive process among various and numerous actors. It also stressed the point that firms do not innovate in isolation and that innovation is collective process where firms interact with other firms and other organizations (such as, universities, research centres, government agencies and financial institutions). The concept is further advanced into *national innovation systems* presented by Freeman in 1988, Nelson in 1993 and Lundvall in 1992. Later on, national innovation system approach has branched out into two directions: a) innovation systems have 'regional' dimension and thus regional innovation systems were identified by Braczyk et al. in 1998, and b) 'sectoral' dimension of innovation system has been suggested by Malerba in 2004 because the ways of actors' embeddedness may significantly differ across industries.
5)	The most recent approach (even it is not certain if it constitutes just a methodology or a new theoretical framework) is the *social network* approach. The idea of embeddedness and social integration of businesses as crucial factors of the success of a cluster is not new. The entirely new in this approach is the endeavour to model and measure empirically all sorts of network effects that are at the centre of a cluster, using the tools and methodologies of social network analysis and graph theory.

Source: Malerba and Breschi, (2005:2-6)

From Malerba and Breschi's (2005) summary of the theoretical frameworks considering clusters it can be concluded that all of the perspectives share a common conception: formal and informal relationships; interactions and networks among diverse actors and institutions; and their geographical proximity. It is believed that all of these contribute to the more advanced learning, knowledge exchange, firm innovation and success of a cluster. Moreover, inter-firm embeddedness and agglomeration between the firms and other organizations is likely to reduce costs of innovation and knowledge transmission, and to lower risk and uncertainty among the technology-intensive firms in the cluster. The importance of clusters and networks for innovation and competitiveness is increasingly recognized by policy-makers (De Propris, 2002). Accordingly, the apparent vitality of small firm agglomerations has resulted in SMEs and networking being one of the main targets of various policies, e.g. industrial, regional, innovation and technology, in many industrialized countries since 1980s (Isaksen, 1996).

While various authors focus on a variety of aspects of the clustering, in the first section of this chapter three overlapping issues that are important for understanding the concept and benefits of clustering and networking will be shortly discussed. These matters refer to importance of innovation, knowledge and collective learning.

The second section of this chapter will be centred around the most common elements and benefits of the clustering and networking for the small, technology-intensive organizations.

2.1. IMPORTANT ASPECTS OF INNOVATION

''.....it is matter of innovation and change....''
Johnson B. and Nielsen K., 1998

Technology intensive organizations and high-tech industries are faced with new challenges in today's business environment. Ability to develop new technologies is central to their innovativeness, success and competitiveness. The obvious fact is that globalisation created different economic trends where focus is no longer on production costs and searching for new markets but on the innovative process itself (Longhi and Keeble, 2000: 27). Environmental changes, such as, intensification of competition, acceleration of technology advancements, enlargement of required investments and globalization of markets, are subject to high-technology industries, where the pace of new technology and product/service development is remarkably high and lifecycle is accordingly short (Yasuda, 2004: 1).

Through the creation, diffusion and use of knowledge, innovation has become a key driver of economic growth and provides part of the response to many new societal challenges (OECD, 2001:3). From the 70's, competitive environment of firms underwent major changes, mainly concerning the growing knowledge-intensity and emergence of innovation-based competition and its globalization (Mytelka and Farinelli, 2000). The 1990s witnessed radical and global technological change, with rapid and research-driven technological developments in high-tech industries which are characterized with high research-intensity, an extraordinary pace of technological change and growth of demand for their product and services (Longhi and Keeble 2000: 44). Mytelka and Farinelli (2000: 7) emphasized that these changes have significantly altered the competitive environment for firms in all sectors and placed a greater burden on small and medium-sized enterprises to engage in a continuous process of innovation. The number of literature points out that small, technology-intensive firms which favour networking and clustering, proliferated in high-tech sectors. They have found the ways to develop innovative

solutions through the collaboration and linkages with the other public and private enterprises, and/or knowledge institutions.

Why innovation is important in contemporary analysis? Today, there is no doubt that innovation is one of the key factors underlying growth and thus, the manner in which innovation takes place has been a major concern since the mid-1980s (OECD, 2001: 91). Innovation has evolved from single-act philosophy of innovation (Fischer, 2006) to systemic approach where innovation is seen as interactive activity in which learning is fundamental process and knowledge the fundamental strategic resource (Lopez M. R., 2000). After transition from Fordism to post-Fordism, innovation process has changed and innovation activity is characterized with two features: 1) there is increased significance of incremental innovations compared to the linear model of innovation, and 2) innovation became a process of interactive learning between firms and their external environment where this environment is conceptualised in terms of ''national or regional systems of innovation'' (Smith, 1994). Vast amount of economic and managerial studies in the last decade have emphasized importance of innovation for the competitiveness of not just a single firm but clusters and regions as well. The interactive nature of innovation process leads to a model of spatial systems of innovation which underlines importance of co-operation between firms and institutions, and thus, the role played by networks involving different actors (Fischer, 2006)

Accordingly, vast amount of scholars directed their work towards the understanding innovation process and observing innovation from various perspectives. There are various definitions of innovation and various approaches to define it. Majority of the authors do agree upon the fact that innovations can refer to new or improved products and processes, new organizational forms, the application of existing technologies to new fields, the discovery of the new resources, and the opening of the new markets. However it is not easy to define innovation precisely. Thus, our aim is neither to discuss definitions of innovation nor to concentrate on one of them. In this section, the goal is to emphasise the recent literature on innovation that points out: a) inter-firm interactions and relationships between firms and other institutions as a vehicle to foster and advance innovation, and b) proximity as a contributor to the process of innovation. Additionally, innovation is closely related to knowledge and thus cannot be separated from the concept of knowledge and

process of learning in today's global economy. This is taken into consideration through the following theoretical discussions. As a result, we want to emphasize that small technology-intensive organizations can be active in the process of innovation if they are engaged in the cluster or network, and that they can extract benefits of clusters and networks if they tend to engage in the inter-organizational relationships.

2.1.1. Innovation as an Interactive Process

The basic assumption in the theoretical literature is that innovation is social, complex and interactive process where emphasis is on the importance of interactions among various actors. Innovation results from increasingly complex interactions at the local, national and global levels among individuals, firms and other knowledge institutions (OECD, 2001:3). Increasing complexity of the innovation process requires more face to face communication and informal linkages among the firms. Successful innovation demands access to specialised regional research and professional labour markets, university and research institute, technology competences, and existing networks of innovative high-tech firms (Longhi and Keeble 2000: 51). The evolutionary economists, such as Schumpeter in 1939, Nelson and Winter in 1982, and later the systematic theories of technical change, at national level by Lundvall in 1992 and Nelson in 1993, regional level by Saxenian in 1994, sectoral level by Carlsson and Stankiewick in 1991, and firm level by Kline and Rosenberg in 1986, emphasized that firms do not innovate in isolation but in continuous interaction with other sources of knowledge (OECD, 2001:91). Keeble et al. (2000) accentuate that innovation process brings together various technological capabilities and implies links between different actors.

Powel (1990) pointed out that sources of innovation do not reside exclusively inside firms, instead, they are commonly found in the interstices between firms, universities, research laboratories, suppliers and customers. Powel et al. (1996) further argues that the locus of innovation is found in networks of learning and inter-organizational relationships, rather than individual firms. They emphasized (ibid. p. 119) that network of inter-organizational relationships serves as a locus of innovation because it provides timely access to knowledge and resources that are otherwise unavailable, while also testing internal expertise and learning capabilities.

Moreover, Powel et al. (1996) stressed out that in high-tech industries collaboration is more than ''formal contractual exchange'' and that ''beneath most formal ties, then, lies a sea of informal relations''. They also argued that firms in bio-tech industry that has relationship with other firms grow faster than firms that do not have such ties; they are more likely to deepen their ties; and they have more competence and experience. They found (in the field of bio-technology) that networks of collaboration enable access to the relevant knowledge that is not easily produced inside the boundaries of a firm or obtained through market transactions.

Oerlemans et al. (2001) argued that innovation is embedded and that innovative outcomes are influenced by an actors' relationship with a variety of external actors. External co-operation enables firm to obtain external resources that it may lack. Thus, external resources are related to the precondition that firm must have co-operation with external actors. However, their critical view on the firms' embeddedness and innovation leads to conclusion that innovation will have higher output and it will be more effective and efficient if firms possess and know how to utilize both, external and internal resources. Powel et al. (1996) claim in the same manner that a firm's value and ability as a collaborator is closely related to its internal assets, but at the same time, collaboration further develops and strengthens those internal competences. Oerlemans et al. (2001) showed on the sample of firms in Netherlands that having resources is not enough. What matters for the success of innovation is actual utilization of external as well as internal resources. Moreover, one of their findings implies that if innovation as a complex phenomena causes many problems for the firm, that firm is more likely to interact with the external actors.

Mytelka and Farinelli (2000) draw attention to the system of innovation approach as a conceptual framework that emphasize interactive process in which enterprises in interaction with each other and supported by institutions and organizations (such as, industry associations, R&D centres, university and training centres, financial institutions, etc) play a key role in bringing new products, new processes and new forms of organization into economic use.

Wilkinson and Moore (2000) draw attention to collaboration, interaction and networking between firms and other bodies embracing university/research

organizations and institutions as a key feature of innovation systems where information and knowledge is diffused and innovation is enhanced through the processes of co-operation.

De Propris (2002) provides the evidence that firms clearly benefit from engaging in co-operation in innovation and firms are more likely to be innovators if they co-operate with other firms than if they do not. In the same manner, Kitson and Michie (1998) found that innovative firms tend to be involved in formal or informal collaborative partnerships more than non-innovative firms.

These and many other findings tend to provide the evidence that firms do not innovate in isolation. Innovation, technology, knowledge, their creation, utilization and diffusion, together with inter-firm and firm-organization linkages and collaboration, are all interconnected, intertwined and mutually interdependent. Moreover, they must be studied as such entities.

2.1.2. Innovation, Knowledge and Collective Learning

At the down of the twenty-first century, process of networking, innovation, knowledge development and collective learning within European and US regional clusters of technology-intensive firms appears to lie at the heart of these regions' undoubted economic success (Longhi and Keeble 2000: 52). Here, learning from the others and knowledge, particularly tacit knowledge, play huge importance in development of the firm's competences.

Most scholars divide knowledge into two types: 1) explicit knowledge or information, and 2) tacit knowledge or know how (Dyer and Nobeoka 2000: 348). While explicit knowledge is easily codified and transferred, tacit knowledge is complex and difficult to transfer. In the same manner, Ernst and Kim (2002) define explicit knowledge as knowledge that is codified in formal and systematic language and, thus, it can be combined, stored, retrieved, and transmitted with relative ease and through various channels. On the other hand, they refer to tacit knowledge as knowledge that is deeply rooted in the human body and mind and thus it is hard to codify or communicate. Further they emphasize that tacit knowledge can only be expressed

through action, commitment, and involvement in a specific context and locality, and its diffusion requires face-to-face interaction.

Dosi (1988:1126) has suggested that ''tacitness refers to those elements of knowledge that individuals have which are ill-defined, uncodified and unpublished, which they themselves can not fully express and which differ from person to person, but which may to some significant degree be shared by collaborators and colleagues who have common experience''.

Tacit knowledge embraces many forms, e.g. skills and competences that are specific to individuals or group of co-operating individuals (Fischer, 2006). Oerlemans et al. (2001), among the others, stressed out the importance of tacit knowledge and the interactive character of development of technical knowledge and innovation. Tacit knowledge is bounded to people and is transferred through informal learning in local communities (Isaksen, 1996) and, thus, important elements of tacit knowledge are collective rather than individual (Johnson and Lundvall, 1995). Tacit and informal knowledge, widespread in the local area, play a fundamental role in the innovative process and in the industrial development of clusters: human relationships, trust, common language and beliefs allow faster transfer of information and easy knowledge sharing (Carbonara, 2002).

The basic assumption in the theoretical literature is that geographical distance affects the ability to receive and transfer knowledge (Oerlemans et al., 2001: 340). Gulati (1995) and other scholars made arguments about the obstacles to inter-firm knowledge transfer. According to them, the most important impediments are created by distance and cultural differences, among the other factors. Kirat and Lung (1999:34) put it in this way:

> "In the case of tacit knowledge, the formulation of the message cannot be separated from its sender either because the sender is unable to express it abstractly or because the formulation only takes on meaning in an immediate interaction with partners, along with a necessary adjustment or a trial-and-error innovation which assumes geographic proximity. The proximity of the agents participating in the innovation process is thus not only a factor in the generation of knowledge, but also a powerful reducer of learning and communication costs within this dynamic."

Wilkinson and Moore (2000: 240) see the proximity as an opportunity for shared social and cultural environment which further provides the channels and means for

the knowledge exchange, trust and co-operation necessary for collective learning to take place. Baptista (2001) supports the idea that tacit knowledge flows more easily through interpersonal contacts and that it should depend positively on the proximity of technologically close firms. His empirical work for the UK confirms the importance of geography and inter-firm networking in the process of knowledge transfer and diffusion.

Fischer (2006) stressed out that tacit forms of knowledge and technological learning are localized and territorially specific and thus, firms that master tacit knowledge are tied into different types of networks and organizations through localized input-output relations, especially knowledge spillovers. He suggests that firms, especially small firms have to develop and enhance their *absorption capacity* (i.e. ability to learn, assimilate and use knowledge developed elsewhere) by learning from and interacting with other firms and organizations, and by taking advantages of knowledge spillovers. He further emphasizes that knowledge spillovers occur when knowledge created by a firm is not contained solely within that firm, thereby creating value for other firms and organizations, either without compensation or with compensation less than the value of the knowledge. Firms, thus, may increase their benefits by implementing knowledge generated by other firms in the cluster. This implies that knowledge creation and innovation are dependent on the inter-firm relationships and collective efforts. Moreover, Fischer (2006: 101) argues that centrality of knowledge spillovers in the process of knowledge generation and innovation is at the root of the formation of formal and informal networks. Baptista and Swan (1998) argued that importance of knowledge spillovers can make geographical proximity vital to innovative activity. Baptista (2001) also underlined that spillovers have a crucial impact on the diffusion of new knowledge, which further promotes innovation and organizational improvement, and supports adoption of new technologies. Caniels and Romijn (2001) argue that spillovers are facilitated by opportunities that firms in cluster have to establish direct contact with each other, such as through inter-firm labour mobility and formal or informal exchange of information and ideas.

Today, learning is comprehended as a central and crucial element of innovation process. Recent studies characterize the economy today as knowledge-based since knowledge and learning capabilities became key of the economic success for the

economic agents. According to Lundvall (2007), focus should be on people, competences, relationships and interactions among institutions where key of success for individuals, firms and other systems is rapid learning. Kirat and Lung (1999) indicated that knowledge grows within organizations as a result of cumulative learning process. Same as innovation and developing new technologies, learning process must be understood as social and complex process which requires interaction among the various actors.

> "The more complex the learning process, the more interactions it probably requires. Professional researching in universities, research institutes and R&D departments, which is characteristic of the modern economy, also involves many forms of intense interacting inside research communities and between these and other communities and individuals." (Johnson and Lundvall, 1993: 75)

Powel et al. (1996), Dyer and Nobeoka (2000) support the common attitude of various scholars who recognized that inter-firm learning is critical to competitive success and that organizations learn by collaborating with other firms and by observing and importing their practices. Kirat and Lung (1999: 29) states that the interactive characteristics of learning signifies that developing the capability of both communicating among different actors and creating knowledge represents a vital factor in the economy's dynamic efficiency. Baptista (2001) stresses that research on networking and geographic clustering of firms leads to the conclusion that localized pattern of development enables a collective learning process and increases the speed of knowledge transfer by reducing uncertainty.

Firms located in close proximity to other firms and knowledge institutions are given opportunity to access and exchange tacit knowledge with the other entities throughout collaboration and inter-firm linkages, as well as to develop codes of collective learning and collective knowledge generation. Geographical proximity is not a necessary condition for developing networks and interactions among both the firms and the firms and other institutions. However, geographical proximity of various actors can ease the process of forming the linkages. In turn, this can lead to the development of trust among the actors and strengthening ties that can contribute to the collective learning, transfer of tacit knowledge, and hence development of innovation. Kirat and Lung (1999: 31) put it this way: ''A proximity that is merely geographic in nature can provide the basis for the presence of an agglomeration of firms, yet not necessarily for the presence of an innovation system''.

2.1.3. Summary

Globalisation and rapid change in technology created the need of putting technological innovation at the core of the firm's competitive strategy. In this aspect, inter-organizational linkages and mutual learning has increasing importance for innovation and economic growth. Moreover, cooperation amongst firms and between firms and other organisations is not only possible but frequent, probably increasingly so due to enhanced 'connectiveness' brought about by globalisation and the spread of Information technology (Teubal, 2002).

Firms do not innovate in isolation. Innovation is closely linked and intertwined with tacit knowledge, technology and learning. The production of new knowledge or of novel technique occurs endogenously and is inherent to the process of producing innovation (Kirat and Lung, 1999). Interaction became a central element in the process of innovation since innovation requires learning and since co-operation among the firms and organizations is crucial for exchange of tacit knowledge. Thus, innovation is fostered and enhanced inside the network and due to inter-firm collaboration. Moreover, innovation is bounded to the geographic proximity where proximity of various actors eases the inter-organizational co-operation and exchange of tacit knowledge, and, thus, supports the development of innovation. Most emphasized advantages of proximity are based on the absence of communication barriers, availability of external resources and lower transaction costs. Firms, inter-connected in the geographic proximity, can extract the benefits of innovation that became one of the most important sources of competitive advantage.

Technology and innovation became extremely complex, expensive and time-consuming entities. The new technologies and knowledge are often not in possession of the small, technology-intensive firm. Moreover, transfer of tacit knowledge and know-how often necessitate development of long-term relationships. Hence, small and technology-intensive firms need to develop ability of collective learning and networking with other related companies, knowledge institutions, governments and other financial organizations in order to access missing internal and external resources and become innovative. By developing interactions and social relationships these firms are able to better exploit available internal resources

and potential, and use benefits of joint ventures that can be developed through clustering and networking. Making use of external knowledge and using partners to access lacking assets have consistently been stressed in the innovation literature as key to innovative success. Firm's capacity to put innovation at the core of the business is seen as strategy that harness benefits from technological change and the globalisation of markets (OECD, 2004: 9). All of this is due to the fact that innovation does not emerge from the singular efforts of entrepreneurial firms or corporate research centres, rather, it is produced within networks that are collective in character and hold a crucial territorial dimension (Camagni 1990: 140).

Baptista (2001) stated that small businesses are more likely to be unable to develop the necessary technology and innovation capabilities when isolated. Information exchange and adoption of new technologies from others allow small businesses to develop specific competences and improve on others methods (Baptista, 2001: 32). If the small technology-intensive firms are interconnected in the web of networks and at the same time in close proximity to each other and knowledge institution they can produce more efficient and more effective innovation output. Thus, for small and medium enterprises (SMEs), clustering is believed to offer unique opportunities to engage in the wide array of domestic linkages among various actors (e.g. users, buyers, universities, R&D institutes, etc.) of an economy that stimulates learning and innovation (Mytelka and Farinelli, 2000). Small firms operating in high-tech industries can profit for their own competitiveness and success of their regions if they are able to extract benefits from the advantages of clustering.

Technology, innovation, knowledge and learning are concepts that are interweaved and tightly connected to concepts of networking, clusters and inter-firm relationships. Clustering and networking approaches help in comprehending the importance of collaboration between diverse economic units and collective learning for the sake of technology progress and innovation.

2.2. NETWORKS, CLUSTERS, SOCIAL RELATIONSHIPS AND BENEFITS OF THE LINKAGES

General conception of the innovation process supports the relevance of networking and clustering of resources (OECD, 2001:91). The stronger the linkages with other sources of knowledge, the better the firm will perform in terms of innovation and growth (OECD, 2001:91). Many authors emphasized that networking is central to the innovation process. Here, cluster approach emerged as useful framework within which to analyse the networks linking diverse agents (OECD, 2001:91).

The growth of regional clusters of mainly small and medium enterprises in Western Union and North America since the 1970s has gained great interest among both academics and policy makers (Isaksen, 1996). Some of the remarkable examples include Silicon Valley, Orange County, and Boston's Route 128 in USA; Cambridge, Oxford, Grenoble, and Sophia-Antipolis in Europe, and many others. In the '70s and '80s such clusters established a strong position in the world market for both more traditional products (e.g. Third Italy) and high technology products (e.g. Silicon Valley), and in some industrial sectors they proved as more competitive than large firms (Isaksen, 1996). Since then, much of the literature is centred around inter-firm collaboration and cooperation, strong links with local knowledge centres such as universities, and the development of a regionally-embedded capacity for collective learning (Keeble 2000: 1).

Analyses of clusters have emerged as key issues in the research agenda of scholars from quite diverse economic fields (Breschi and Malebra, 2005:1). Following successful cases in the United States and Europe, many regions have been trying to imitate these examples, setting up science parks, technopoles, venture capital and financial innovation support schemes (Breschi and Malebra, 2005:1). However, there is neither a standard cluster approach, nor fixed policy recipe for implementing the cluster approach in practice (Bergman et al., 2001).

Despite the economic and strategic importance of clusters, it was not until the '90s when scholars renewed the focus of research (Cuerco-Garcia et al. 2008). In recent years vast amount of studies have made attempts to analyze the role of clusters in economic activity, both in developed countries, where accent is on the high-tech

sectors, and in developing countries, where clusters are seen as tools for increasing companies', regions' and countries' competitiveness and international positioning (Cuerco-Garcia et al. 2008).

It is believed that in '90s globalization and technological change led to the growing importance of the cluster and network concepts. Some authors have distinguished between two general lines in the cluster literature. One concerns the economics and managerial literature, mainly centred around Porter's and Krugman's work, that brings to the fore economic externalities revealed by Marshall in the 1890. The other line of the literature pertain to socio-economic and innovative aspects, and it draws attention to the territorial, social, institutional, and cultural factors underpinning cluster dynamic. It is also known as network paradigm (studied by Powell in 1990s) and it embraces the innovative milieu school by Campagni in 1991 and Milliat in 1996, the Nordic School of innovation and learning by Lundvall and Maskell in 2000, and the geography of innovation approach by Audretch and Fledman in 1996 (Cuerco-Garcia et al. 2008).

It must be emphasized that clusters come in many forms, each of which has a unique development trajectory, principles of organization and specific problems (Mytelka and Farinelli, 2000: 11). One broad distinction can be made between clusters that are 'spontaneous agglomerations of firms and other related actors' and those that are 'induced by public policies' (Mytelka and Farinelli, 2000: 11). The latter is also referred to as 'constructed clusters' (Mytelka and Farinelli, 2000: 11) and encompasses techno-parks, industrial parks, incubators, and so forth. In the following sections we will pinpoint particular characteristics concerning clustering and networking perceived as the most relevant for this thesis.

2.2.1. Defining Clusters and Networks

The seminal works of Porter in 1990 and Krugman in 1991 have motivated a growing number of academics to study the empirical evidence on clusters, definition, and impact on economic policy and business decision-making (Cuerco-Garcia et al. 2008). Even though clusters have been defined by numerous authors, there is neither consensus on the definition of the clusters nor clear identification of

their key factors, characteristics and effects. However, our aim in here is not to criticize diverse definitions, but to compare them in order to extract common features of the cluster approach. These prevailing characteristics will further aid in emphasizing elements and benefits of clustering.

The most widely accepted and used definition is that of Porter (1998:78):

> ''Clusters are geographic concentration of interconnected companies and institutions in a particular field.''

GREMI group (Camagni 1991, and Keeble 2000) initiated the concept of 'innovative milieux' that is defined as a complex network of informal relationships in a limited geographic area that enhances local innovative capability through 'synergetic and collective learning processes'. Albino et al. (2005) define clusters as a geographical system of firms where ''a system of firms is a set of elements (firms) that interact with each other and with the surrounding environment to achieve a common objective''. Cuerco-Garcia et al. (2008) emphasized that clusters are characterized as encompassing a set of tangible assets, such as companies and infrastructure, and intangible ones, such as knowledge, technologies, and know-how; and institutional elements such as public administrations, training and research centres, that act interconnectedly in a geographic space.[1]

Cooke (2002:121) claims that his definition of the clusters is more complete and a preferable one:

> ''Cluster is geographically proximate firms in vertical and horizontal relationships involving a localized enterprise support infrastructure with a shared developmental vision of business growth, based on competition and cooperation in a specific market field.''

Networks and clusters are interconnected concepts. Although there are certain differences pointed out in the literature, we will study networks as a crucial ingredient of clustering. The same as clustering approach, networks are analysed by a great number of scholars and from various theoretical perspectives, at different

[1] For more definitions see Appendix A

levels and with different conclusions. We will point to the common and most important aspects of networks as a form of relationships among numerous actors[2].

In literature, the basic assumption of network relationships is that each party is dependent on resources controlled by another, and that there are gains to be held by the pooling of resources (Powel, 1990:303). In the same manner Gulati (1995) describes strategic interdependence between organizations as a situation in which one organization has resources or capabilities beneficial to but not possessed by the other. Camagni (1991) defines network as a closed set of selected and explicit linkages with preferential partners in a firm's space of complementary assets and market relationships, having as major goal the reduction of static and dynamic uncertainty. Bergman and Feser (2002) use the term business network to identify a group of firms with restricted membership and specific, and often contractual, business objectives likely to result in mutual financial gains. They further emphasize that members of a network choose each other for a variety of reasons; they agree explicitly to cooperate in some way and to depend on each other to some extent; and networks are more likely to develop within clusters, particularly due to the fact that repeated business transactions have created familiarity and build trust.

Notwithstanding various definitions and a variety of approaches to define or study clusters, most definitions share the notion of clusters as networks of companies and institutions that are geographically concentrated for the purpose of achieving collective benefits. Thus, it can be assumed that the basic elements constituting characteristics of clustering are geographical proximity; networks of inter-firm linkages; and networks between companies and other institutions. These matters will be analyzed in more details in the following sections.

[2] As Powel (1990) pointed out, these actors can pertain to firms and other institutions, as well as to individuals, independent production teams or very small business units. Thus, networks can encompass inter-organizational relationships, personal ties or market relationships among various parties.

2.2.2. Impact of Geographical Proximity on Innovation Capability, Clusters and Networks

As it was stressed at the beginning of this chapter, there are different theoretical frameworks that are used to study the formation of networks in geographical space, such as Marshallian industrial districts and externalities, innovative milieu approach, new industrial spaces approach, the network approach, and national and regional systems of innovation. Despite the distinct theoretical starting points, all of them share general agreement on the importance of geographical space for innovation (Oerlemans et al. 2001: 340). The primary idea is that innovation process benefits from local clustering.

The geographic proximity refers to the fact that companies are located in close proximity to each other as well as in close proximity to the other institutions (e.g. universities, research laboratories, administrations, etc.). Geographic proximity thus can be defined as positioning of agents within a predetermined spatial framework (Kirat and Lung, 1999). Despite the globalization and emergence of global markets, geographical proximity and benefits it may generate are still widely discussed and studied in the literature. An increasing number of scholars have re-examined the role of proximity when addressing issues related to technological, innovative and economical performance of firms (Larsson and Malmberg, 1999). Porter (1998:90) asserts this matter in the following way:

> ''In a global economy – which boasts rapid transportation, high-speed communication, and accessible markets – one would expect location to diminish in importance. But the opposite is true. The enduring competitive advantages in a global economy are often heavily local, arising from concentrations of highly specialized skills and knowledge, institutions, rivals, related businesses, and sophisticated customers.''

In current literature focus is on the innovation, knowledge and learning as the main factors that contribute to the firms' ability to continuously upgrade their competitiveness. This fact brought with it an increased interest in the role of firm's environment when it comes to stimulate these processes (Larsson and Malmberg, 1999). Thus, in this section we will examine some of the main theoretical

approaches and empirical findings[3] laying behind the concept of geographical proximity in relation to innovation and benefits it can create for firms in the cluster.

The term ‘’agglomeration economies’’ used in the literature refers to advantages that firms can obtain in a regional network or a cluster. The general idea behind the concept is that environment of the firm has a positive influence on its output (Caniels and Romijn, 2001). Emphasis is on the fact that geographical proximity, and thus clustering, generates benefits for innovation and forms the basis for economic growth.

Regarding this issue, reference is often made to the Marshallian types of advantages for an individual firm located within a cluster as discussed previously. According to the standard agglomeration perspective, those firms that are clustered in close geographic proximity and share access to local pool of resources can obtain economies of scale and scope, speedy and accurate exchange of information and other resources, and minimization of transaction costs associated with transportation, communication, labour recruitment, etc. (Staber, 1996a,b). Moreover, Staber (1996a) argues that spatial proximity may not be equally important for all business areas, but it can be highly beneficial for the business activities that require frequent face-to-face interaction.

Piore and Sabel (1984) in the *new industrial spaces model* analyzed the qualitative factors which facilitate quantitative external economies of co-location. Their analysis of territorially bounded networking goes beyond standard agglomeration and transaction cost reasoning (Staber, 1996a). What they argued is that spatial proximity, in the regions and communities that have a tradition of co-operation and territorial identity, creates synergies as well as encourages innovation. The geographical proximity as well as direct relationships creates an environment where information, codes, languages, organization routines, and strategies are easy to be shared, activating mechanisms of learning by localizing and collective learning (Piore and Sabel, 1984). What may matter most is not proximity per se but whether social relationships lead to generation of trust, loyalty and tacit understanding, and

[3] However, theoretical arguments predominate in the literature on ‘economies of proximity’. This is due the fact that rich flow of theoretical contributions is not matched by an equally rich source of empirical evidence (Larsson and Malmberg, 1999)

whether these outcomes enhance firms' willingness to share risks and resources (Staber, 1996a). Staber (1996) also points out that geographic proximity promotes mutual trust and partnership, but it also stimulates continuous innovation through direct rivalry. According to him, co-location implies additional quality that gives firms the incentives to interact in trustworthy manner and it is the basis for intense interpersonal interactions.

One of the concepts that has opened the way to the interpretation of economic dynamics in terms of spatial relationships is ''*innovative milieu*'' (Camagni 1991, Keeble and Wilkinson 2000, Keeble 2001). The main focus of this model is on processes of knowledge sharing and interactive learning. Camagni (1991) stress out that economic space became the field of social interactions, interpersonal synergies and social collective actions that determine the innovative capability and the economic success of specific local areas. Here, emphasis is on the significance of spatial proximity not just in sense of reduction of physical distance and related transportation costs, but rather in terms of easy information interchange, similarity of cultural and psychological attitudes, frequency of interpersonal contacts and inert-firm cooperation, and density of mobility within the local area. Hence, the proximity of firms is crucial for fostering and maintaining network amongst the firms which in turn enhances the capability of cluster firms to generate dynamic processes over time, which further significantly enhances flexibility to respond to changing environment, the innovativeness and capacity for learning, and creation of new knowledge by the cluster's firms (Camagni 1991, Keeble 2001).

Camagni (1991: 132-134) explains in more details that ''proximity matters'' in threefold way due to:

> *(i) Presence of local resources of human capital that is highly mobile within the territory and which accounts for much of the local collective learning process, enhancement of productivity and the creation of a local external 'image' (example of Silicon Valley is enlightening in this respect);*
>
> *(ii) Presence of complex network of mainly informal contacts among local actors, building what Marshall called an 'industrial atmosphere' within industrial districts, made up of personal face-to-face*

contacts, casual information flows, customer-supplier relationship and the like;

(iii) Presence of synergy effects that stem from a common cultural, psychological and often political background; this common roots contribute to establishment of tacit codes of behaviour, decoding of complex messages and to the formation of common 'representations' and widely shared 'beliefs' on products and technologies.

Furthermore, Von Hippel (1994) emphasized that the proximity of the agents participating in innovation process is not only a factor that generates knowledge, but also a powerful reducer of learning and communication costs within this dynamic. Many authors, Porter (1998) and Cuerco-Garcia et al. (2008) among the others, stressed in the same manner that geographical proximity improves communication and facilitates the flow of information. According to Porter (1998) local outsourcing is better than distant outsourcing, especially when advanced inputs involve technology, information and service.

Porter (1990) argues that proximity increases the concentration of information and, thus, probability of it being noticed and acted upon; increases the speed of information flow and rate at which innovation diffuse; raises the visibility of competitor behaviour and awareness of matching improvements; raises the number of spin-offs as they have tendency to locate near the original company; and attracts talented people. He (1998) also highlights that geographic proximity of companies and institutions, and the repeated exchanges among them, fosters better coordination and trust. He further points out that geographic, cultural, and institutional proximity leads to special access, closer relationships, better information, powerful incentives, and other advantages in productivity and innovation that are difficult to utilize from distance. Porter (2000) later argues that building of innovative capacity leads to improvements in productivity where local relationships, including those with university, facilitate this process.

Lundvall (1992) drew attention to the relation between innovation and proximity by emphasizing that more radical innovation requires localized ties. He also acknowledged that innovation is complex and interactive process that became foundation of competitiveness for firms, regions and nations. However, critics of his

work point out that Lundvall considers only user-producer ties and that he offers little on how to empirically test his theoretical claims (Oerlemans et al., 2002).
Mowery et al. (1996) highlighted that proximity to the network of other firms, universities and other business services is critical to innovation. Baptista (1996:60) argued that 'geographical concentration' is of foremost importance for organizational improvement and technological innovation. Later on, Baptista and Swann (1998) found that firms which produce in cluster are more innovative than those that are not in cluster. They stressed the importance of knowledge spillovers and information sharing on innovative activity with special accent on proximity which fosters direct contacts with a variety of sources (e.g. competitors, suppliers, customers, universities and research laboratories).

Advantages that proximity may bring to small firms allow them not only to survive but to prosper as well. Case studies conducted in the Third Italy and Silicon Valley, among the other successful cases, confirmed that territorial uniqueness is highly profound and crucial for innovation, exchange of tacit knowledge and speed of diffusion of new technologies inside these 'clusters'. Findings of Gulati (1995), Mowery et. al. (1996) and others, suggest that obstacles to inter-firm knowledge transfer are produced by distance, cultural differences, and other factors. All authors that favour positive effects of geographic proximity highlight that it is one of the factors that explain enhanced and accelerated transfer of tacit knowledge, and innovation creation and diffusion in the clusters (industrial districts or science and technology parks). Positive effects of the geographic proximity may be summarized as follows:

- Face-to-face interaction is eased which further may foster development of inter-firm and firm-organization linkages;
- Creation of social capital i.e. trust, common language and common culture is supported;
- Flow of information and exchange of tacit knowledge between firms and/or other institutions, and hence interactive learning, are facilitated;
- Access to specialized workforce is eased and mobility of the labour is facilitated;
- Diffusion of knowledge spillovers and academic research spillovers are eased.

These positive factors may highly contribute to creation of relationships and/or strengthening of inter-firm and firm-university cooperation and networking. Further, networking among the actors located in close proximity can contribute to the innovative capacity and competitiveness of both, individual firms and clusters.

However, Kirat and Lung (1999) emphasized that proximity that is merely geographic can provide the basis for agglomeration of firms, yet not necessarily the presence of an innovation system. They stressed that potential for such a system depends on technological proximity as well as on geographic proximity where collective action rationale, shared rules and collective learning are from crucial importance. Cooke (2002:128) asserts that embeddedness and geographic proximity go together to create cluster. This implies necessity of cooperation and networking among the actors situated in the geographic proximity if the utilization of cluster advantages is to be achieved.

2.2.3. Networks Amongst the Firms

Recent work on the growth of small, high-tech firms in the US and Northern Italy suggests the model of externally-driven growth in which network of relationships enable small firms to gain and establish foothold almost overnight (Powel, 1990).

Networks are complex, they require substantial efforts and time to be established and sustained. However, it is believed that once established they tend to be characterized by a high degree of interdependence, intensive communication, reciprocity and trust (Fischer, 2006). It is also important to emphasize that local networks appear to be more durable because these networks are reinforced by social, cultural and symbolic bonds made possible by geographical proximity and frequent contacts (Baptista and Swann, 1998).

2.2.3.1. Interactions and Relationships

The extent of networks between companies located in the cluster is related to the set of interdependent relations that are willingly established between the companies, or between individuals, or among business units.

Sorensen (1996) proposes that interaction refers to daily activities or episodes, and it is the establishing of short-term relationships. Throughout the ongoing interactions, firms create long-term relationships with other firms. Hence, interactions between the firms generate the inter-firm relationships over time (Ritter and Gemünden, 2003). Relationships are seen as considerable investments in time, money and effort; and are the means by which knowledge as well as other strategically important resources are both accessed and created (Wilkinson and Young, 2002). Ritter and Gemünden (2003)[4] summarized important features of an inter-organizational relationship as follows:

- *Relationship has a long-term orientation*
- *Relationships change over time, they are not static and each relationship is unique*
- *Relationships do not come free of costs (it is lengthy and costly investment as it requires money, resources and time)*
- *A relationship has an atmosphere that can be described in terms of power, trust, commitment and adaptation*
- *Relationships are mainly maintained for an economic purpose.*

When relationships become interconnected and interdependent, they form a network (Sorensen, 1996). In the same manner, Ritter and Gemünden (2003) highlight that relationships do not exist in isolation or independent from each other which had impact on moving focus of research from individual relationships to a network. Hence, building of long-term relationships is one of the key mechanisms of the network theory (Sorensen, 1996).

[4] Ritter and Gemünden (2003) pointed out that relationships have been called in the literature as inter-firm relations and alliances, and have been building blocks of virtual organizations and outsourcing.

Network building is a social process through which the actors gradually and voluntarily establish close relations of long-term duration (Sorensen, 1996: 8). Hakansson and Johanson (1992) stressed the importance of three elements which mutually influence each other in building the networks: actors (actors perform activities and control resources), activities (activities transform resources and are used by actors to achieve goals) and resources (give actors power and enable activities). According to Sorensen (1996), actors throughout daily interactions attain personal experience of the other actors which in turn (if the interaction is successful) lead to cooperation, trust, commitment, mutual adaptation and even routinization of the relationships. Johanson and Mattsson (1992) emphasized that even though long-term relationships bind the network, networks are both stable and changing, and long-term relationships are continuously established, maintained, changed and dissolved as a consequence of the daily activities.

Sorensen (1996:11) summarized network mechanism as follows:

- *Interaction creates personal experience and information flow, and may lead to cooperation;*
- *Cooperation incurs intensive social relationships which, in turn, may result in the creation of trust and mutual orientation;*
- *Trust opens up for commitment, mutual adaptation which further generates interdependence;*
- *Trust also opens up for asset specific investments and thus asymmetrical relationships.*

As it was stated earlier, inter-firm networks can be observed from different perspectives and levels. Inter-organizational levels of analysis used in the literature encompass: *the interaction*, *the dyad*, *the portfolio*, *the net*, and *the network*. Moreover, many authors distinguish between *vertical* (i.e. relationship between firms operating at different production and marketing stage in the production chain) and *horizontal relationships* (i.e. relationship between firms operating at the same or similar stage in the production chain). Additionally, inter-firm networks can be *formal* and *informal*. Formal linkages can be managed by different types of contracts and arrangements, while informal relations are mainly based on the trust and are in the form of conventions, informal rules and habits.

2.2.3.2. Key Concepts Underpinning Networking

Powel (1990) contributes to the network theory by emphasizing three factors as critical components of networks. These are know-how, demand for speed and trust.

Know-how is mostly based on tacit knowledge that exist in the minds of people and that is difficult to be codified.[5] Thus, networks of firms are seen as suitable forms which facilitate and foster the relationships between highly skilled labour force. This in turn enables networks of small firms to arise and proliferate in the knowledge-intensive activities (such as, scientific research, design work, computer programming and software development, professional services, and so forth) in today's knowledge-based economy.

Changes in environment and greater importance of innovation today led the firms to realize and favour benefits of networking. Powel (1990) highlights the strength of network forms of organization, such as fast access to information, flexibility and responsiveness to changing tastes, as highly important in reducing risks and sharing the expense of developing costly products that have very short life spans. Thus, considering the fact that competition is today based on factors such as the ability to innovate and translate ideas into products quickly, network forms of organization are more likely to proliferate.

Networks lead to co-operation and generation of the trust between the actors. Powel (1990) emphasizes that trust reduces complex realities far more quickly and economically than prediction, authority or bargaining. He further emphasize that networks should be more common in the cases where participants have some common background – ethnic, geographic, ideological or professional. Thus, it is possible to generate higher level of trust in such homogenous groups as well as to sustain networks of relationships.

Sorensen (1996) stressed the importance of concepts of ''cooperation'' and ''trust'' as key concepts in the Network Theory. He relates cooperation to the concepts of:

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[5] Tacit knowledge and its importance for innovation are discussed in the section 2.1.3.

i) *''competition'': Within networks, there is continuous competition for creating the best co-operative long term relationships and thus, competition within and among networks has the importance for the networking dynamics;*
ii) *''power'': Although, power is in the direct contrast to cooperative relationships where voluntarism and mutuality dominate, the concept of conflict and power are valid constructs and they take place within a cooperative atmosphere;*
iii) *''coordination'': Coordination is important in the sense that firms depend on each other in the network and their activities need to be coordinated;*
iv) *''opportunism'': Opportunism, as a self-interest seeking with guile, is restricted in the network by the promotion of cooperation where cooperation prevents the potential opportunism from unfolding; and*
v) *''commitment'': Commitment, seen as efforts to maintain a valuable relationship, is essential for the concept of long-term relationships. Cooperation and commitment are mutually interdependent.*

Sorensen (1996) further argues that if two actors trust each other, they have certain expectations for each others' behaviour, where these expectations are based on experience, i.e. they are built up gradually over time. In the same context as Powell (1990) and Sorensen (1996), and Staber (1996b) stress that trust between networks' actors can minimize the need for planning as well as transaction costs which to a large extent are incurred to prevent opportunistic behaviour and breakdown of cooperative relations. Sorensen (1996) also emphasized that cooperation and trust are mutually interdependent in the sense that they enforce each other. Most of the scholars argue that trust is a necessary and critical condition for the long-term relationships, exchange of resources (e.g. tacit knowledge, information, technical know-how, personnel and so forth), making risky investments, reducing uncertainty and sharing novel ideas. Trust is important when business activities involve uncertainty, resources are scarce, and information is limited (Staber, 1996b). Trust is a key resource for holding actors in network together (Staber, 1996b).

Network is a flexible but changeable mode of organization and network building is a complex exercise in balancing:

- *Independence/interdependence against dependence*
- *Cooperation against conflict*
- *Trust against opportunism*
- *Mutual orientation against power*
- *Access to resources against control over resources, and*
- *Flexibility against interlocking rigidity (Sorensen, 1996:11).*

2.2.4. Networks with Other Institutions

Institutional networks refer to the relationship between companies on one side and non-governmental and governmental organizations within the cluster on the other side (Cuerco-Garcia et al. 2008). Keeble (2000) sees importance of firm-organization networking as a hub of the successful and continuing growth of the regional clusters. In his study of European high-technology clusters, he argues that network's research provides evidence of the existence of active local inter-firm and firm-organization processes in all successful high-technology SME regional clusters. These linkages further promote learning, knowledge development, and exceptional levels of technological research and product innovation where regional collective learning process lies at the heart of the recent evolution and competitive success of the successful regional clusters (Keeble, 2000:220).

The successful examples of Third Italy and Silicon Valley has several key outcomes:

1) *blurred boundaries of the firm,*
2) *they represent the spatially concentrated production that involves the cooperation of local government, proximity to centres of higher education, a highly skilled labour pool, extensive ties to research institutes and trade associations, and cooperation among firms with specialized skills and overlapping interests,*
3) *small, technologically advanced firms exhibited growth as a result of expansion through various cooperative inter-organizational relationships (Powel, 1990).*

In this section we emphasize the university-firms relationships as it is perceived to be the most relevant for this thesis.

Cooperation between the firms and knowledge institutions, namely universities, is perceived in the literature as highly important and beneficial. This is due to the fact that knowledge centres serve as a means of disseminating research, providing services, and educating and training future workforce (Cuerco-Garcia et al. 2008). Smith and de Bernardy (2002) assert that universities are: a) source of highly skilled labour (i.e. they supply graduates, they train the existing local workforce through continuing education departments, and they attract highly qualified workforce from outside); b) source of new firms (i.e. they provide ground for university spin-offs and encourage academic entrepreneurship); and c) sources of technology (i.e. they can stimulate innovative activity of the firms). Camagni (1991), in the innovative milieu theory, argues that proximity to university means proximity to sources of highly skilled labour which are highly mobile within a cluster. According to Camagni (1991), Keeble (2000) and Smith, and de Bernardy (2000) this proximity, together with university-firm relationships, accounts for much of collective learning inside the cluster. According to Keeble (2000), the role of the knowledge institutions, namely universities, in promoting collective learning in the cluster encompasses:

- creating preconditions for regional collective learning in terms of informal networks of former students and researchers, and SME research cultures of collaborative innovation
- generating local technology-based spin-offs as a source of new innovative firms and regional technology competences
- training scientists, engineers, researchers and other graduates where recruitment of this highly-qualified labour by cluster firms is seen as one of the most crucial ways in which local universities can shape and foster the growth of a cluster
- collaborating with cluster firms in R&D.

Further, Keeble (2000) emphasizes that process of knowledge diffusion and development which leads to dynamic process of regional collective learning is fostered by the movement of key individuals and skilled workers carrying technological and managerial know-how and ‘embodied expertise’ between firms and other organizations (e.g. universities, research institutes, etc). New spin-offs are

seen as important type of this movement not just for the knowledge transfer and development but for the generation and sustainability of inter-firm and firm-university linkages. According to Keeble (2000), founders of these spin-offs often maintain close relationships with their 'parent' organization, creating, thus, opportunities for networking, collaboration and the development of further 'untraded interdependences'. The successful examples studied by Keeble and Wilkinson (2000) show the high percentage of spin-offs. One of them is Cambridge cluster where 88% of high-tech SMEs are spin-offs or new start-ups founded by entrepreneurs formerly working for a local firm (56%) or university (19%).

In the same manner, Longhi and Keeble (2000) stress that universities provide an important local source of knowledge and spillovers to innovative economic activities. Successful spin-offs from university in a favourable cultural context can trigger a cumulative process and growth based on these spillovers, as for example, has occurred in Silicon Valley and Cambridge (Keeble and Longhi, 2000). In this manner, Acs et al. (1994) showed that spillovers from university contribute more to the innovative activity of SMEs than to that of large firms, and Jaffe (1989) demonstrated that such spillovers are very localised and decline over time and over space.

Fischer et al. (2006) emphasize interactions between firms and university as crucial for the exchange of knowledge within the innovation process. They emphasize that (ibid: 137):

- *Direct personal interactions (such as, face-to-face communication) generate social capital, such as trust and common language and culture, which further facilitate exchange of knowledge and information. Here, geographical proximity can contribute to creation of social capital through personal interactions between university and firm members because of the common background;*
- *Exchange of tacit knowledge, as well as new knowledge (which can be considered as a new combination of existing knowledge) occurs through personal interactions and communication processes between individuals (discussed in the section 2.1.3. of this thesis). Transfer of tacit knowledge between university and firms occurs by mobility of*

graduates who are equipped with a high amount of tacit knowledge acquired at universities i.e. by hiring graduates by firms;

- *Interactions can be formalized. This is way to ensure a sufficient level of trust and to reduce uncertainty. For example, formalization of interactions is used to commit human resources to objectives and views;*
- *The length of interaction, the sequence of interaction and the resource engagement on both sides affect the type, volume and efficiency of knowledge exchange between university and firms.*

Table 2. lists the types of knowledge interactions that are believed to be especially relevant for the university-firms interactions. For the purpose of this study, 'employment of graduates by firms', 'new firm formation by university members', 'training of firms members', 'collaborative research, joint research programmes', 'contract research and consulting', 'use of university facilities by firms', and 'licensing of university patents by firms' are considered as factors for determining relationship between university and firms, whereas the other factors will be used for the policy and future work recommendations.

Table 2. Types of knowledge interaction between university and firms

Types of knowledge interaction	Formalization of interaction	Transfer of tacit knowledge	Personal (face-to-face) contact
Employment of graduates by firms	+/-	+	-
Conferences or other events with firm and university participation	-	+/-	+
New firm formation by university members	+	+	+/-
Joint publications	-	+	+
Informal meetings, talks, communications	-	+	+
Joint supervision of PhDs and Master thesis	+/-	+/-	+/-
Training of firm members	+/-	+/-	+
Mobility of researchers between university and firms	+	+	+
Sabbatical periods for university members	+	+	+
Collaborative research, joint research programmes	+	+	+
Lectures at university held by firm members	+	+/-	+
Contract research and consulting	+	+/-	+
Use of university facilities by firms	+	-	-
Licensing of university patents by firms	+	-	-
Purchase of prototypes developed at university	+	-	-
Reading of publications, patents, etc.	-	-	-
+ (interaction that typically involves formal agreements, transfer of tacit knowledge, personal contacts)	- (interaction that typically does not involve formal agreements, transfer of tacit knowledge, personal contacts)		
+/- (interaction with varying degree of formal agreements, transfer of tacit knowledge, personal contacts)			

Source: M.M.Fischer et al. (2006:138)

One of the important factors of clustering, as mentioned before, is the pool of specialized workforce. Besides the existence of the specialized workforce, majority of the scholars emphasize the importance of linkages between individuals, and labour mobility among knowledge (and/or research) institutions and the business sector as the most important channels and central process in transmitting tacit knowledge, learning and building up of trust among the partners. Mobility and interactions can be facilitated by close proximity of agents. Different types of knowledge interactions among the university and firms actually represent various strategies for ensuring research efficiency and obtaining access to scientific and technical opportunities (Fischer et al. 2006).

Keeble and Wilkinson (2000), as well as Keeble and Longhi (2000) emphasize the growing importance of the role of the universities in stimulating the development of regional SME technology clusters. Beside the formal collaborative links between firms and university, the accent is on the wider and very important role of such knowledge centres. This role is illustrated by examples of long-term significance of university and research institute spin-offs in, among the others, Cambridge and Sophi-Antropolis clusters. This argument is being supported by the evidence from Cambridge where research showed that formal links with Cambridge university were ranked only eleventh in the list of 19 region-specific development advantages, whereas the 'credibility, reputation and prestige of a Cambridge university' was ranked no less than second by the 70% of the high-tech SMEs surveyed (ibid. pp.13).

Smith and de Bernardy (2000) describe that contribution of the university to high-tech clusters through process of interaction and knowledge development includes:

- Spin-offs
- Attraction of inward investments
- Innovation stimuli (through technology transfer, information flow and knowledge resources)
- Highly-qualified labour (through training and movement of such labour)
- Identity (through image creation and prestige that generate cultural characteristics of the region).

Thus, it is suggested that clustering engenders significant competitive advantage for the constituent firms because of the: ease with which new professional, technical and market-relevant knowledge can be accessed and shared via personal and business networks (Keeble and Nachum, 2001); local mobility of highly-qualified staff; university spin-offs and knowledge spillovers; and proximity to and collaboration with university or other non-governmental and governmental organizations.

However, even though in this thesis we analyze proximity, inter-firm and firm-university co-operation within the cluster, the importance of external linkages must be pointed out. Authors such as Keeble and Wilkinson (2000), Keeble and Nachum (2001), and Camagni (1991) stress the need for accessibility to global networks, clients and knowledge so that local firms may attract the complementary assets they need to proceed in the economic and technological race. They argue that international linkages should not be seen as replacing the need for local networking and embeddedness, but rather as an essential and complementary source of new knowledge, information and expertise in an increasingly globalised economy.[6]

2.2.5. Motives for Networking

In this section, an attempt is made to examine some of the most widely cited motives that lead firms to co-operate in their innovative efforts. Better understanding of motives can aid in the proposing policies for cooperation and networking among firms and other organizations; and for better understanding of benefits firms located in the close proximity can extract if they engage in networks with other actors.

Firms enter various types of inter-firm collaborations and partnerships in order to integrate their strengths and overwhelm their weaknesses. There are various forms of cooperative relationships that led small firms to become faster and more capable

[6] Keeble and Nachum (2001) emphasize that recent work has even demonstrated that within particular knowledge-intensive clusters such as high-technology SMEs in Cambridge and Oxford, it is the most globally-networked firms which are also the most locally-embedded in terms of collaborative and research linkages.

in pursuit of innovation and product development. Such networks include: collaboration that facilitates research and pooling of research staff; R&D partnerships; sharing information and know-how; new product development; joint production/service agreements; co-marketing collaborations; transfer of technology; joint education and training programmes; collaboration in the fairs, exhibition and publishing; consultancy and so forth. These types of relationships are more likely to cause the sharing of critical information and tacit knowledge as well as creation of trust and common values. There is common agreement in the literature on networks which support the idea that exchange of distinctive competencies, such as tacit knowledge, skills and technological capabilities, is expected to occur in networks rather than through a market transaction.

The traditional explanation for why firms enter collaborations and form networks is related to transaction cost theory. However, these explanations are centred on transaction characteristics, static efficiency and routine situation, and thus do not capture the strategic and social factors which propel many firms into the collaboration with other actors (Eisenhardt and Schoonhoven, 1996).

Kogut (1988) summarized three main motivations that can be applied to various types of networking: (i) transaction costs, (ii) strategic behaviour driven by competitive positioning and its impact on profitability which means that firms try to enhance their competitive positioning or market power, and (iii) quest for mechanisms to transfer organizational knowledge or learning.

According to Powell et al. (1996:116), the most common motives for collaboration embrace some combination of risk sharing, obtaining access to new markets and technologies, speeding products to market, and pooling complementary skills. Moreover, firms cooperate to acquire resources and skills they cannot produce internally, when the hazards of cooperation can be held to a tolerable level (Powell et al., 1996: 118). The collaboration is most likely to occur when there is need to reduce uncertainties associated with rapid technological development and novel products or markets. In this respect, no single firm has all the internal capabilities necessary for success (Powell et al., 1996).

According to Mowery et al. (1996), rationales for collaboration encompass: need to share the development costs and risks of innovation, penetration to foreign markets, increasing market power (strategic motive), coordinating and formulating technical standards and dominant designs (users and suppliers relationship), and acquisition of new technical skills or technological capabilities from partner firms. Mowery et al. (1996: 79) highlight that one of the most widely cited motives for collaboration is the acquisition of new technical skills or technological capabilities from partner firms. This is due to the fact that firm-specific technological capabilities are frequently based on tacit knowledge and are subject to considerable uncertainty (Mowery et al., 1996: 79). Thus, Mowery et al. (1996) conclude that the acquisition of technology-based capabilities is an important goal and effect of inter-firm collaboration.

Gulati (1998) states further that factors that influence inter-firm collaboration can be distinguished between industry-level (e.g. extent of competition, the stage of development of the market, demand and competition uncertainty) and firm-level (e.g. resource contingency such as strategic vulnerability, size of the firm, competitive position, product diversity and financial resources). Gulati (1998: 295-296) also suggests that network of contacts between the firms can be a valuable source of information for the participants, and what matter is not solely the identity of the members of a network but the pattern of ties among them as well.

Camagni (1991:135) stresses out that through a network firms obtain access to important complementary assets, markets and technologies without incurring organizational or locational costs, and free themselves from the limits of local and internal competence. Powel (1990) recognized that networks are especially apt for the exchange of commodities whose value is not easily measured, such as tacit knowledge, know-how, technological capability, particular approach or style of production, spirit of innovation or experimentation, etc. In the same manner, Hagedoorn (1993) highlights that cooperation creates necessary complementary technology inputs which enable firms to capitalize on economies of scope through joint efforts. He also stresses that firms can gain from joint monitoring of environmental changes in combination with developing new products and processes through cooperation.

Hence, we can list the following rationales for cooperation that has been mostly emphasized in the literature (Kogut 1988, Powel 1990 and 1996, Camagni 1991, Hagedoorn 1993, Eisenhardt and Schoonhoven 1996, Mowery 1996, Gulati 1998, Fischer 2006):

- To obtain greater pay-off when firm is in a vulnerable strategic position (i.e. highly competitive industry, new markets, many competitors or pioneering technology)
- To benefit from economies of scale in joint R&D and production
- To improve strategic position
- To gain market power, to enter quickly to new markets or to obtain entry to foreign markets
- To create new products or to expand the existing product range
- To share costs and risks (e.g. costs and risks of the research in high tech-industries are high)
- To reduce, minimize and share uncertainty (which is inherent to R&D and innovation)
- To capture competences, innovative and technological capabilities of partners
- To obtain critical resources quickly (such as, tangible recourses – financial assets, or intangible ones – know-how, reputation, skills) and synergies of resource sharing
- To gain visibility and information about buyers, suppliers, employees, customers, manufacturing, etc.
- To improve or advance technological innovation (e.g. by joint product development, transfer of technology, etc.)
- To reduce the total period of the product life-cycle and shorten the period between invention and market introduction
- To gain fast access to new technologies of partners (e.g. transfer of technology) and to advance technology development
- To tap into sources of know-how and new knowledge located outside the boundaries of the firm
- To share and advance basic scientific and/or technological knowledge (e.g. joint research activities, sharing the technology, etc.)

- To access technological synergies, near-future results of general scientific knowledge and relevant complementarities of technologies

The need for cooperation and networking among the firms and other institutions stems from the tacit nature of knowledge, increasing importance of learning, technology and innovation, costly and risky R&D, changes in environment, globalization, and intensified competition in knowledge-based economy, to name some of them. This is especially significant for small, technology-intensive organizations that want to become competitive in today's uncertain environment. Therefore, current literature stresses the importance of networking and clustering if these organizations are to proliferate and obtain advantages of networks and clusters. Some of the particular advantages of networks and clusters, mostly emphasized in the literature, are discussed in more details in the following section.

2.2.6. Advantages of Clusters/Networks

There is an agreement in the contemporary literature that clusters became a leading model for economic development in the knowledge-based economy of today. Hence, business economists promote clusters and networks as specific modes especially where rapid productivity and innovation gains are key features of global competitiveness (Cooke, 2002). Policies that aim at promoting clustering and networking are actually directed towards the utilization of advantages that these strategies can generate at the firm, region and/or national level of analysis. In the following part of this section some of the advantages of networks and clusters will be described.

Advantages of clustering defined by Marshall, discussed previously, are the basic point of departure for almost all scholars. Furthermore, two immensely popular and interrelated literatures, namely 'innovative milieux' by Camagni (1991) and Keeble (2000), and industrial clustering by Porter (1990) have been highly influential. The central hypothesis of this literature is that sub-regional clustering of related activities has the potential, if suitably encouraged, to generate stronger social networks between businesses, which would promote successful innovation and competitive advantage (Gordon and McCann, 2005).

Powel (1990) summarized some of the most important features of the networks as: they greatly enhance the ability to transmit and learn new knowledge and skills; they ease search for new ways of accomplishing tasks; they promote learning and exchange of information; and they generate trust. This implies that network forms of organization represent a rapid means of gaining access to physical and human resources, information, skills and know-how that cannot be produced internally.

Moreover, firms that are engaged in networks have advantages for the acquisition of technology-based capabilities because firm-specific technological capabilities are frequently based on tacit knowledge and are subject to considerable uncertainty considering their characteristics and performance (Mowery et. al., 1996:79). This advantage is obtained due the fact that inter-firm collaboration facilitates transfer of tacit knowledge among the firms. Tacit knowledge is recognized as becoming increasingly important given the rapidly changing global economy (Bergman and Feser, 2002), and, thus, eased exchange of tacit knowledge reinforce advantages of networks and clusters. According to Bergman and Feser (2002) such advantages are likely to be strongest for technology-intensive firms that seek to improve flexibility and ability to innovate.

Sorensen (1996) argues that network provides the following advantages:

- *Trust reduces transaction costs and uncertainty*
- *Experience and knowledge about the partners' needs increase the innovative potential*
- *Intensive information flows increase the opportunity to engage in the new business opportunities*
- *Voluntary cooperation assures flexibility*
- *Commitments assure access to resources controlled by the others.*

We can also add the advantages of collective learning capacity for creating, exchanging and diffusing new, tacit knowledge reinforced by frequent contacts and developed trust among the various actors engaged in network. This particular advantage is mostly emphasized by 'innovative milieux' literature and it argues that networking between the firms, and among the firms and other institutions, generate better opportunities for learning which is a prerequisite for improvements in productivity and economic performance.

Another important advantage of networking and clustering, often mentioned in the literature, refers to the time. The time necessary to establish expertise or to gain market share will be shorten in the network of partners (Fischer, 2006). Moreover, firms that are part of the network are more likely to be able to exploit developments in a technology in a timely manner and to facilitate problem-solving tasks through sharing of experience gained by dealing with similar technologies (Baptista and Swann, 1998). Hence, quicker access to required resources, capabilities and know-how, new markets or new technologies can speed up innovation and ensure competitive advantage of small technology-intensive firms being engaged in the network.

Caniels and Romijn (2001) identified five main types of agglomeration advantages, namely: (i) economies of scale, scope and transaction in activities aimed at production of goods and services; (ii) economies of scale, scope and transaction in activities aimed at the production of new knowledge and skills; (iii) knowledge spillovers stemming from changing attitudes and motivation; (iv) knowledge spillovers stemming from informal learning-by-doing; and (v) knowledge spillovers associated with transfer of technological information.

The fındıngs of Keeble and Nachum's (2001) analysis of clustering in England, indicate that cluster firms recognise and value their ability to tap into a collective learning capacity provided by the whole cluster's firms, organizations and pool of highly-qualified labour and expertise. They also add that the cluster itself signals quality and credibility to potential clients seeking reassurance in a very uncertain and imperfect service market-place. Following findings from their study in London cluster composed of small and medium management and engineering consultancies, they point out, in the 'innovative milieux' tradition, particular benefits that firm may obtain in the cluster:

(i) Clustering of firms is influenced by the need for and benefits of proximity and accessibility to clients. Locational prestige and positive image of the cluster create quality and credibility of constituent firms as a further and significant cluster benefit;

(ii) Localised process of knowledge acquisition, development and networking for cluster firms is highly important. High rates of spin-off of new firms from existing local businesses are present in the successful clusters. Personal

contact networks are significant and are comprehended as a key source of new knowledge (particularly professional and market knowledge), implying thus a dynamic process of knowledge generation and diffusion between firms and other actors in the cluster. Spatially-concentrated flows of professional stuff with their 'embodied expertise' between firms are common. Hence, growth of the cluster and its constituent firms has benefited significantly from the development of localised collective learning processes, knowledge acquisition and sharing, as a further determinant of clustering;

(iii) Notwithstanding the networks among the cluster firms, access to global networks, clients and knowledge is perceived as very important for small firms in cluster. Cluster is characterized by a high level of openness to and interaction with the global economy as an essential source of knowledge, expertise and market opportunities. Hence, clustering of SMEs enables a process of localised collective learning and global networking as complementary sources of competitive advantage for SMEs performance and growth.

Within the field of economics, Krugman's approach to increasing returns with his so-called 'new economics of geography' is the most well-known and most cited one (Buendia, 2005). Krugman (1991) argues that firms locate in clusters because the 'cluster environment' provides advantages, such as the proximity of customers and suppliers, a joint labour pool and the presence of knowledge and information.

One of the most widely cited theories referring to cluster advantages for firms and countries is that of Porter (1990, 1998). Porter (1998) stressed out that a cluster of independent and informal linkages among the companies and institutions represents a robust organizational form that offers advantages in efficiency, effectiveness and flexibility. Porter (1998) describes a number of advantages derived from clustering that has been emphasized and discussed by many authors, such as Oerlemans et al. (2001), Cooke (2002), and others.

Firstly, these benefits encompass an *increase in the productivity of firms* based in the cluster due to better access to employees and suppliers; access to specialized information; complementarities; access to institutions and public good; and better

motivation and measurement. Availability of a pool of specialized and experienced employees lowers firm's search and transaction costs. Sourcing locally is considered to be cheaper in the sense that it lowers transaction costs, minimizes need for inventory, eliminates importing costs and delays, and lowers risks associated with suppliers' behaviour. This is because of the existence of high trust relations and the importance of reputation-based trading (Cooke, 2002:121). Besides, personal relationships, community ties and face-to-face contact foster trust and facilitate flow of knowledge and information. Members of cluster have privilege in accessing this information. Complementarities between the activities of cluster members come in many forms (products complementarities, coordination of activities across the companies, joint marketing mechanisms e.g. trade fairs, and so forth) and they enhance productivity. Access to public goods from knowledge and research institutions (Cooke, 2002:121), as well as collective investments in such goods (training programmes, infrastructure, laboratories, and so on) can be advantageous and can have collective benefits.

The second advantage refers to *innovation gains and company's ongoing ability to innovate* due to proximity and interactions among the firms, and between firms and other entities (e.g. customers and suppliers as Porter points out). Innovation as an interactive process and learning can be facilitated by frequent face-to-face contacts among the actors in the cluster. Relationships help companies to learn earlier for instance, about evolving technology, service and marketing concepts, and so on. Thus, clusters can make innovation more visible and provide capacity and flexibility to act rapidly. Besides, proximity to knowledge centres and qualified personnel are of key importance to knowledge transfer (especially when knowledge is tacit rather than codified), where informal know-how trading is easier in clusters than through more distant relationships (Cooke, 2002:121).

Finally, *new business formation* is fostered in cluster environment where information about innovative potential, knowledge and market opportunities is locally available. The argument for this lays in the fact that the needed assets, skills, inputs and staff are often readily available in the cluster, and they can be assembled more easily for a new firm. A geographic concentration of firms and other institutions, a clearer perception of unfulfilled needs, product and/or service gaps, and anticipated demand, all lower entry barriers and risks of entry for new businesses.

We argue that firms that develop and maintain linkages with other firms and institution, and firms that are settled in the close geographical proximity have a potential to extract benefits from a network or a cluster. Small technology-intensive firms need to access external sources of information, knowledge, know-how and technologies, in order to build their own innovative capability and to reach their markets, and they must also engage in networks, particularly those that nurture the tacit knowledge and other non-tradable competencies that are critical for pursuing innovation-based competitive strategies (OECD, 2004:5). Notwithstanding the importance of knowledge and innovation in contemporary environment, the benefits that firms can obtain from cluster go beyond the transfer of knowledge and innovation which was presented above.

2.2.7. Summary

The most fundamental characteristic of the current knowledge-based economy is the growing extent to which actors need to co-operate more actively and more purposefully with each other in order to cope with increasing market pressures stemming from globalization, liberalisation of markets and changes in the technology (Fischer, 2006). Growth of clusters comprised of SMEs, inter-firm networks and closer integration of research, development, production and marketing among the firms and other institutions are evident in the economy. Many authors emphasized that successful clusters of technology-intensive firms showed exceptionally high levels of inter-firm and organization networking and collaboration.

As it was discussed in previous sections, knowledge creation, diffusion and transfer, are interactive and collective processes among various actors i.e. individuals, firms and other organizations. Along with this, there is an increasing importance of inter-firm cooperation and networking for innovation process that is featured as complex, costly and risky activity. Interaction and knowledge exchange between firms, research centers, universities and other institutions are at the heart of the analysis of innovation process (Bergman and Feser, 2002). According to Camagni (1991), and innovative milieu approach, creativity and continuous innovation are seen as the outcome of a collective learning process, fostered by intergenerational transfer of know-how, imitation of successful managerial practices and technological

innovations, interpersonal face-to-face contacts, formal or informal cooperation between firms, tacit circulation of commercial, financial or technological information. Long-term economic growth and competitiveness of the small, technology-intensive firms depend on collective learning capability, access to tacit knowledge and its application to innovation processes, all of which can be achieved through networking and clustering.

Besides their interactive character, knowledge, innovation and technology are reinforced by close geographic proximity. Close proximity of firms and institutions support frequent interactions and facilitate generation of social capital and trust as important prerequisites that foster cooperation and innovation.

Current literature pinpoints knowledge, innovation and technology as driving forces of long-term economic growth, primary basis of competitiveness and sustained competitive advantage. The cluster concept has become increasingly associated with the 'knowledge' economy. The argument in here is that processes that drive the development of new economic knowledge and its application and commercialization in innovation are facilitated by localization (Simmie, 2006). Informal information, knowledge and academic spillovers, as well as information and knowledge transfer associated with local inter-firm labour mobility, all contribute to the creation of environment in which the external net benefits of localization more than compensate any congestion costs associated with clustering (Gordon and McCann, 2005). Additionally, innovation is seen as a dynamic social process that evolves most successfully in a network in which intensive interaction exists between those 'producing' and those 'purchasing and using' knowledge (Bergman and Feser, 2002). In such circumstances of contemporary world, where interactions and proximity are highly essential, networking and clustering are seen as the most suitable strategies for SMEs that aim to grow and proliferate in high-tech sectors. Hence, this thesis focused on the importance and advantages of inter-firm relationships and network inside the cluster.

Among the linkages between firms and other organizations, university-firm linkages were discussed as being the most relevant for this thesis. It can be summarized that the most important contribution of the universities, stressed out by the majority of scholars, is seen as publishing findings of their research, providing services,

educating highly-qualified labour, transfering tacit knowledge, and generating spin-offs.

We argue that important advantages that firms, specifically small technology-intensive firms, can obtain from inter-firm and firm-organisation networks inside the cluster is through capturing the external knowledge, resources, competences and information. Further, tacit knowledge obtained and diffused through collaboration can lead to the generation of new products and processes. Collective learning and trust are fostered by frequent cooperation and close proximity. Inter-firm and firm-institution networks can open up new opportunities for success that SMEs would not be able to capture if operating in isolation.

We also argue that clustering can generate advantages for SMEs such as, higher level of innovativeness, growth, flexibility, ability to deal with complexity, uncertainty and risks, higher levels of productivity, increased profitability, and increased competitiveness.

However, it is important to remind the significance of external linkages for the success of cluster and constituent firms. Some scholars such as Camagni (1991) and Keeble (2000), stressed the importance of external linkages with other clusters and/or regions. According to them, regional collective learning, in order to be sufficient, requires some inflow of expertise, know-how and new embodied knowledge from other technologically innovative regions and countries. This is due to the fact that high-tech clusters in order to be successful need to be linked into wider national and international labour markets.

2.3. TECHNO-PARKs

When an inventor in Silicon Valley opens his garage door to show off his latest idea, he has 50% of the world market in front of him. When an inventor in Finland opens his garage door, he faces three feet of snow.
J.O. Nieminen, CEO of Nokia Mobira, 1984

Today economy is characterized as knowledge based, global and interlinked where innovation and innovativeness play the key role in national and regional economic growth and competitiveness. In the current economy the basic economic resources are not material, human resources or capital, but knowledge (EC Report, 2007:54). In conditions of constant advancement in knowledge and fierce competition, technology-intensive firms must remain innovative in order to survive and prosper. Here, clustering and networking are emphasized in the literature as successful strategies among SMEs and new technology-based firms (NTBF) that would not be able to gain sufficient level of innovativeness and prosperity if operating in isolation.

Besides, in this new economy there is a strong need to combine knowledge theory and science with high technology and business practice. Thus, techno-parks as a form of 'constructed' clusters (Mytelka and Farinelli, 2000) play an important role in promoting and strengthening the cooperation between two different environments: academic and business. The role of techno-parks in fostering local development has been object of a number of studies and analysis (EC Report: 54). Since the early 1950s many countries took policy initiatives to encourage development of techno-parks in order to facilitate growth and innovativeness of SMEs and NTBFs. The aim of these policies is mainly directed towards bridging together high technology, industry, and research and development into specific locations (Bass, 1998).

Hence, the establishment of an increasing number of techno-parks in Western countries as well as in newly industrialised economies (such as Southeast Asia, South Korea, Singapore, Taiwan and China) since the 1980s have been motivated by the economic contributions of some high technology industrial clusters, both spontaneous and planned ones (EC Report 2007: 62). The phenomenal growth in the number of technology-based firms around, for example, Stanford University in Palo Alto and Massachusetts Institute of Technology (MIT) in Boston (Saxenian,

1994) in the US provided a role model for the development of techno-parks all over the world. The result was emergence of high-tech centres such as Silicon Valley and Route 128 in the United States, Cambridge in UK, Sophia-Antipolis in France, Tsukuba in Japan, just to name a few.

It is important to point out here that there are several terms used to describe these broadly similar high-tech developments. For example, “Science Park” is used in the United Kingdom, “Technopole” or “Technopolis” is used in France, “Technology Centre” and/or “Technology Park” is used in Germany, “Research Park” as a term is mainly used in the US etc. According to some authors the general name of these developments is “technopole”. However, in this thesis we use name “Techno-park”.

It is also important to emphasize that despite the efforts sparked by the so called “Silicon Valley fever”, not many planned techno-parks have been successful (Malecki, 1991). This prompted some observers to conclude that Silicon Valley, which is the building model of most techno-parks, cannot be cloned elsewhere because it was never planned by the government, and other locales may not have the same culture that nurtured Silicon Valley (Wang et al., 1998). Thus, in the following sections we will identify some of the most common characteristics of the techno-park concept, its linkages and advantages, which will be used as a starting point for policy recommendation. Our analysis and theoretical discussions correspond to the “technology-parks” as defined in the Castells and Hall’s typology (1994) of the technopoles discussed in the following section. We do not intend to imitate the successful cases but rather to pinpoint the missing elements in the METU and Bilkent techno-parks (identified through the field study) that, if adequately enhanced, can reinforce performance of these establishments and their constituent firms.

2.3.1. Characteristics of Techno-Parks: Definition, Typology and Objectives

Techno-parks are thus planned developments (Castells and Hall, 1994) and are seen as providers of a dynamic and attractive environment for innovation (Westhead and Batstone, 1998). They are promoted by governments (central, local or regional), often in association with universities and private companies, in order to

help the generation of the basic materials of the information economy (Castells and Hall, 1994). Despite their long-history in the United States as well as in other countries, there is no generally accepted definition of a techno-park. This is largely due to the diversity of development forms of techno-parks in different countries which makes it difficult to provide one, widely applicable characterization of these infrastructures (EC Report, 2007:52).

The most commonly used definition[7] for a techno-park is that of the United Kingdom Science Parks Association (UKSPA), also used by the International Association of Science Parks (IASP):

> "A Science Park is a business support and technology transfer initiative that:
> a) encourages and supports the start up and incubation of innovation-led, high growth, knowledge based businesses;
> b) provides an environment where larger and international businesses can develop specific and close interactions with a particular centre of knowledge creation for their mutual benefit;
> c) has formal and operational links with centres of knowledge creation such as universities, higher education institutes and research organisations' (EC Report, 2007:54)."

In other words, according to the UKSPA (1996), techno-parks have three fundamental features: they are designed to foster the creation and growth of R&D-intensive firms; provide an environment that enables large companies to develop relationships with small, high-tech companies; and promote formal and operational links between firms, universities, and other research institutions (e.g., federal research labs). Thus, science parks are expected to provide access to critical human and physical capital for innovative companies (Siegel et al., 2003).

Castells and Hall (1994:8) under the term technopoles include:

> "Various deliberate attempts to plan and promote, within one concentrated area, technologically innovative, industrial-related production: technology-parks, science cities, technopolises and the like."

They also refer to technopoles as (ibid. pp10):

> "Specific forms of territorial concentration of technological innovation with a potential to generate scientific synergy and economic productivity."

[7] To see more definitions of techno-parks please refer to Appendix A of this thesis.

According to Benko (2000:158), techno-park concept refers to:

> "A defined space, a focal point where high technology based economic activities, striving for future innovation, are spatially concentrated. This factor theoretically encourages mutual cooperation."

Operationally techno-parks are a group of research organisations and businesses devoted to development of scientifically proven concepts from the laboratory stage to the factory production stage (Benko, 2000). Physically, they are a group small- to medium-sized office and laboratory-type buildings in an attractive landscaped setting (Benko, 2000). The first technology park in the world, Stanford Research Park, was created in 1951. This attracted and spun off numerous high-tech firms in the surrounding region and subsequently led to the formation of the famous Silicon Valley (Wang et al., 1998).

The differences in techno-parks mainly arise because of different actors that initiate the techno-parks: government, regions, universities, high-tech companies, investors/developers (EC Report, 2007:57-58). Moreover, techno-parks differ according to geographical scale they operate on: entire regions and cities, e.g. Japan's `technopolis' projects and large scale urban developments known as science cities; or smaller property developments such as technology parks also known as research or science parks (Bass, 1998).

Castells and Hall (1994:10) propose the following typology of techno-parks:

- *Industrial complexes of high-technology firms that are built on the basis of innovative milieu such as, Silicon Valley and Boston's Route 128. They are spontaneously formed geographical agglomerations of R&D facilities and related manufacturing establishments. Even though they are not deliberately planned, government and universities played a crucial role in their development;*
- *Science cities that are strictly scientific research complexes with no direct territorial linkage to manufacturing, such as Tsukuba in Japan and Siberian city of Akademgorodok;*
- *Technology-parks as a type of deliberately planned high-technology business area. This type of technopole intends to encourage new industrial growth in terms of jobs and production, by attracting high-*

technology manufacturing firms to a privileged space. Examples of Cambridge in UK and Sophia-Antipolis in France are in this group.

From the various attempts of researchers to identify the possible objectives of techno-parks, according to Westhead and Batstone (1999:132) the most common ones seems to be:

- *promotion of university[8]-industry linkages by fostering cooperation between university and constituent firms, and the transfer of technology from university to techno-park firms;*
- *promotion of the formation of new technology-based firms;*
- *encouragement of spin-off firms by academics;*
- *encouragement of the growth of existing technology- based firms;*
- *attraction of the firms involved in leading-edge technologies;*
- *creation of synergy between constituent firms[9];*
- *improvement of the performance of the local economy;*
- *improvement of the image of the location, particularly for areas of industrial decline;*
- *creation of new jobs directly as well as indirectly; and*
- *enhancement of the competitiveness of new as well as existing firms in the region.*

2.3.2. Advantages offerd byTechno-parks

In general, techno-parks are constituted of three main actors: public research centres and/or university, large firms, and SMEs (Castells and Hall, 1994)[10]. We can add to this, management of the techno-park often in the form of Management Company, as an important actor of techno-parks. The combination of these actors,

[8] University or Higher Education Institute (HEI).

[9] Where synergy is seen in terms of networks connecting individuals from many different organizations within a system that encourages the free flow of information and generation of innovation (Castells and Hall, 1994:224).

[10] It should be highlighted that majority of the firms located in techno-parks is usually of small and medium size. Moreover, firms in techno-parks are technology-intensive because they operate in high-tech sectors.

territorially concentrated, provides numerous clustering benefits for the constituent firms, as well as for region in general.

According to the literature (Castells and Hall, 1994, Benko, 2000, European Commission 2007, Ferguson and Olofsson, 2004, Monck et al., 1988, Castells, 1996) we identified four different levels of benefits that can be generated by techno-parks:

- Techno-parks may provide the visibility and hence attraction to wider local strategies aiming at the creation of encouraging conditions for high-tech industries to prosper. Example of these strategies can be favourable tax and credit incentives. Techno-parks can contribute to the 'right mix' of research excellence, entrepreneurial activity and public support strategies that is prerequisite for region to be identified as a 'region of knowledge', 'science region', or 'creative region'. At the same time, techno-parks can generate an environment where new ideas, valuable information, pool of skilled labour and technological innovation can emerge and be available for and easy accessible by the constituent firms. Hence, techno-park offers benefits and support for both, local high-tech base and constituent firms.

- Techno-parks provide the advanced infrastructure on which research-intensive and technology-intensive enterprises rely. Here, high priority is given to the presence of research and training institutions, access to university's facilities and resources, a good transportation system, an adequate telecommunications, environmental quality, and prestige and image of the site. For example, techno-parks have been identified as 'centres of knowledge and innovation' and they are becoming increasingly an image of high-tech regions offering hence technological and commercial reputation to the constituent firms. This is why many firms look for the image of quality and innovation that is associated with techno-parks. Besides the location factors, being in close proximity to a university and possible partners creates proper conditions for informal exchanges between enterprises, and between enterprises and university, creating thus a specific social milieu. Proximity of various actors in techno-park eases access to information, finding a collaborator, and access to market knowledge (Benko, 2000). In addition to this, proximity further facilitates new company creation and mobility of workers. Thus proximity allows

establishment of a specific infrastructure dedicated to the creation and transfer of technology (Benko, 2000).

- Techno-parks provide complementary services and support to constituent firms. Techno-parks provide wider support services that allow constituent firms (spin-offs, SMEs, technology-intensive firms) to better focus on their core business and on research for the development of innovations. These services range from administrative matters and management support, to technology brokering. Stronger development and growth of techno-park firms can be supported by help of techno-parks in managing transfer of technology and business skills of constituent firms (Ferguson and Olofsson, 2004). At the same time, techno-park contributes to greater interactions between different actors. Thus, the role of techno-parks is also in facilitating access to other firms located in the same techno-park (or near by) and to their clients, in contributing to the strengthening of diverse institutions within the local innovation system, and in stressing the innovation process and the knowledge exchange (EC Report, 2007:53).

- Techno-parks are usually associated with strong networking effects, creation of synergy and high levels of social capital, as mentioned above. Social networks allow informal exchange of technological information and new ideas which prove to be essential ingredient for the formation of a self-sustaining techno-park (Castells and Hall, 1994). Thus techno-parks have impact on both informal as well as formal networks[11] of creative interaction among various actors. The social capital developed in techno-parks can facilitate the exchange of tacit knowledge, collective learning, the development of 'community atmosphere', or the greater access to specialized human resources. Moreover, networks and relationships between firms and local universities (or research institutes), that are of great importance to local knowledge networks, emerge and are supported in the techno-park. The most important roles of universities are seen in the: generating of new knowledge (both basic and applied); training of the highly skilled labour; and supporting the process of spin-off of their research into the network of industrial firms and business ventures (Castells and Hall, 2004:230-231).

[11] These networks are heterogeneous and can include diverse actors e.g. knowledge producers, users, disseminators), diverse disciplinary backgrounds or even industrial sectors (EC Report, 2007:53).

Benefits and characteristics of the techno-parks have triggered in recent years great attention among the researchers and policy makers. Even though few successful cases in the strongest sense of that concept can be found in the literature, Castells and Hall (1994:111) after studying many examples in various locations asserted that:

> "…the existence of a technology park in its various forms triggered a process of industrial growth and technological upgrading of the local economy, literally putting these areas on the map of the new industrial geography."

2.3.3. Techno-park Success Factors

Various authors (Castells and Hall 1994, Benko, 2000, UKSPA Annual Report 1996) have proposed different techno-parks' success factors. The most extensive presentation of success factors can be seen in the Figure 2. However, for the purpose of our study we have concentrated on the following ones:

- networks and interactions between the constituent firms;
- relationships with university; and
- highly skilled labour force and mobility of workers.

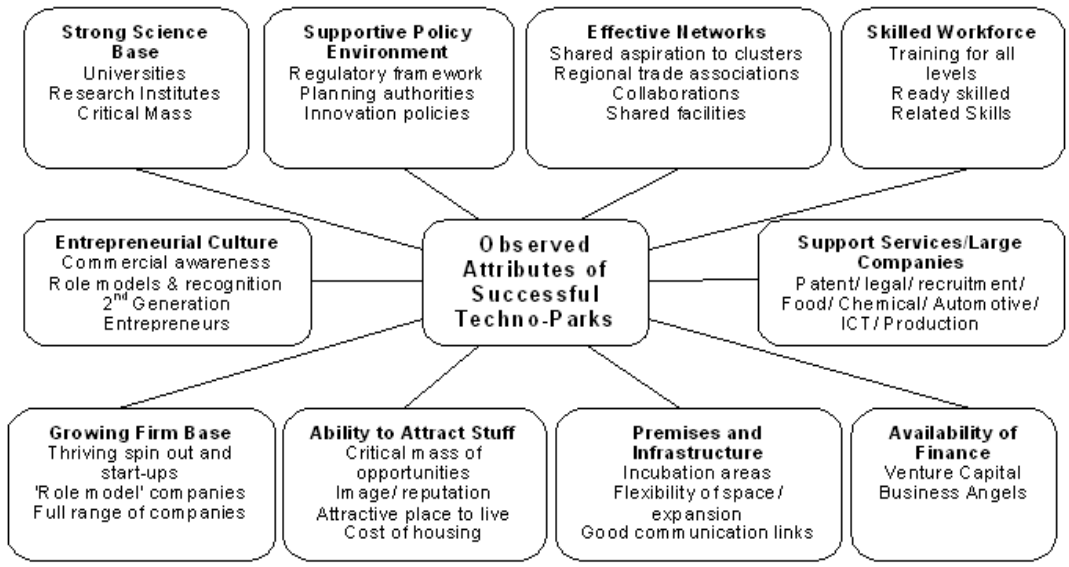

Figure 2. Techno-park success factors

Source: Modified from the UKSPA 1996 and EC Report 2007

2.3.3.1. Networks and Interactions Between the Constituent Firms

In recent years a growing body of literature that emphasizes the importance of regional networking has emerged, as discussed previously. The most often studied cases encompass various sectors ranging from traditional industries (e.g. textiles, shoes, clothing, furniture, etc) as found in the industrial districts of Third Italy, to more advanced ones (e.g. IT, mechanical engineering, biotechnology, etc.) in Germany, Sweden, England, US or Japan. Despite distinctive network systems due to different regional or national institutions and histories (Saxenian, 1994), the logic behind collaboration is the same. Firms chose to become part of a network in order to gain certain levels of success that they would not be able to reach if operating alone. This is especially true for clusters of small, technology-intensive firms.

According to Vyakarnam et al. (2005) the nature of techno-parks can be described as a network environment built on collaboration, exchange of information and sharing of resources (both physical and human) among constituent firms. Ability to generate and maintain inter-firm linkages depend upon the actual physical flow of inputs and outputs between firms and inter-personal contacts for the purposes of achieving synergy, flexibility and qualitative transacting businesses (Westhead and Batstone, 1998). Here, techno-parks offer opportunity for constituent firms to locate in close proximity to other similar and non-similar enterprises. On this way, techno-parks provide an important resource network for NTBFs. (Löfsten and Lindelöf, 2002). Close proximity of firms can support and ease formation of formal as well as informal interactions, and creation of shared identities and mutual trust. Even though technology-intensive firms are usually highly international and possibly linked to the similar regional clusters elsewhere, local relationships inside the techno-park are strategically vital (Saxenian, 1994). This is due to the timeliness significance and enabled frequent face-to face communication that facilitate rapid product development, development of territorial synergy and collective learning. Hence, in this manner, we argue that techno-parks endow constituent firms with the possibility to generate dynamic networks among themselves.

In turn, a networking environment can contribute to the faster diffusion of technological capabilities and know-how within techno-park's constituent firm. Being part of the network within that particular techno-park gives the company easy and

timely access to needed services and know how that it may lack. Through collaboration and social networking, firms are able to:

- access each others' tangible (e.g. human resources, product/service) and intangible resources (such as know-how, information about competitors, customers, markets and technologies, etc.);
- share R&D, technology and new product development (NPD);
- jointly participate in the marketing activities, labor education, fairs, exhibitions, etc;
- develop joint projects.

If the network-based system is pursued, like in the case of Silicon Valley, the techno-park as a whole is able to continuously adapt to fast-changing markets and technologies and to pursuit multiple technical opportunities through spontaneous regroupings of skills, technology and capital of constituent firms (Saxenian, 1994). This will further promote collective efforts and collective learning as essential factors of competitive success for small, technology-intensive firms.

Social networks that exist across firm boundaries are an essential element in the generation of technological innovation, and they are the backbone of the social organization of any innovative locality (Castells and Hall, 1994, Benner, 2003). Consequently, cooperation and interactions among various firms inside the techno-park tend to foster creation of new ideas and innovativeness.

Even though formal networks have proved as a productive interactions in some instances of innovative clusters (e.g. in the Japanese model), informal networks place a crucial role in the generation of new, valuable information and tacit knowledge (Castells and Hall, 1994). Moreover, informal networks among the constituent firms can lead to easier knowledge and information exchange, more innovation, and effective management, which in turn can enhance firms' long-term competitiveness (EC Report, 2007). At the same time a techno-park would become more competitive due to the fact that the success of tenant firms represents the success of a techno-park. According to Castells and Hall (1994) informal networks based on face-to-face interaction over common technical or professional issues may constitute the basis of the process of innovation like in the example of Silicon Valley. These informal linkages can increase in complexity and importance over time and

they can simultaneously convey communication of technological innovation, form organization of the job market, and shape the culture that emphasize the values of technological excellence and free-market entrepreneurialism (Castells and Hall, 1994:18).

Informal networks can further lead to the formation of trust among the firms. This is due to the fact that trustworthiness and quality of the information provided is only assured with individuals and/or enterprises with whom you share common back-grounds and working experience (Saxenian, 1994: 33).

Equally important are personal relationships and networks. The example of Silicon Valley shows that its vitality and flexibility over time as well as its level of technological excellence were only achievable because the Valley itself created social networks among engineers, managers, and entrepreneurs, generating creative synergy that transformed the drive for business competition into the desire to cooperate for technological innovation (Castells and Hall, 1994:28). In Silicon Valley restaurants, bars and even parties were place where engineers met to exchange ideas and gossip (Saxenian, 1994). These informal conversations were pervasive and served as an important source of up-to-date information about competitors, customers, markets, and technologies (Saxenian, 1994:33). Moreover, people with similar interests and experiences came together in various users' groups and hobbyists' clubs (Benner, 2003:1815). Economic actors in the Silicon Valley have become more conscious about the importance of these social interactions and, thus, they put deliberate efforts to create the formal infrastructure to support these 'networking' opportunities (Benner, 2003:1815). As a result, in Silicon Valley there are hundreds of professional associations and similar users groups that make up the dense network of occupational relations (Benner, 2003:1819). Especially striking is the cooperation among the competitors that Saxenian (1994:33) illustrates in the following way:

> "...competitors consulted one another on technical matters with a frequency unheard of in other areas of the country…in Silicon Valley, competitors will not only sit down with you, but they will share the problems and experience they have had…."

Clustering of technology-intensive firms in the techno-park is also assumed to generate additional benefits, such as job creation, technological spillovers,

development and diversification of regional economies, enhanced efficiency, and an expansion of exports (Siegel at al., 2003a). Furthermore, the clustering of high-tech firms in techno-park should serve to stimulate technology transfer and the acquisition of key business skills, such as the ability to develop new products (Siegel at al., 2003b).

Here, we also argue that by engaging in techno-park's networks, constituent firms can attain certain benefits of networks and clusters such as, higher innovativeness and competitiveness, and greater market success.

Although firms' integration and interactions have been important for the growth of a spontaneous high technology industrial clusters and constituent firms, and can help a techno-park to achieve more economic benefits, they have not yet been fully applied in developing techno-parks (EC Report, 2007). Castells and Hall (1994) argue that creation of linkages and synergetic interaction between techno-park's constituent firms is most difficult to achieve.

2.3.3.2. Relationships with Universities

On one side, universities have played a critical role in the development of the techno-parks. Some of the most examined cases in the literature embrace the role of Stanford University at the origin of Silicon Valley, Cambridge University or MIT starting the spin-off process in their area of influence, or the catalytic function of the Ecole Nationale des Mines in the birth of Sophia-Antipolis (Castells and Hall, 1994). The scope of their influence can be seen in two instances: MIT and Stanford. Even though both universities encouraged commercially oriented research, they influenced the emergence of two very distinctive techno-parks: Route 128 and Silicon Valley, respectively[12]. This contrast was generated mainly due to universities' different orientations[13].

[12] Route 128 has been characterized as a cluster based on independent firms and practices of secrecy, centralized authority and vertical information flows (Saxenian, 1994). In contrast, Silicon Valley is featured as a regional network-based cluster that promote collective learning, flexibility and openness; experimentation and entrepreneurship; social networks, informal communication; and collaborative practices (Saxenian, 1994).

On the other side, techno-parks provide mechanisms that continually encourage universities-firms relationships, whether they are in the form of formal links or informal networks. It is argued (Benko, 2000, Vedovello, 1997) that geographical proximity between actors, as provided by techno-parks, has contributed to the improvement of their interaction. Vedovello (1997) goes even further by stating that geographical proximity between universities and firms has worked as a driving force for their interaction.

Universities are providers of both the raw material (new information and knowledge) and the labor force (engineers and scientists) that techno-park firms need (Castells and Hall, 1994). According to Westhead and Batstone (1998), by linking with a university, techno-park firms, in many instances, were able to minimize the `direct' personal cost and risk associated with R&D. For example, by utilizing the resources and skills of an adjacent university, techno-park firms were able to assimilate and exploit available technical information which could be commercially exploited in association with the university and/or other firms (Westhead and Batstone, 1998). Linkages with universities thus enable firms to enhance their technology, market information gathering and dissemination of such knowledge and information. This in turn can positively contribute to firms' innovative ability and capacity, and hence improve their competitive performance (Vedovello, 1997:501). Thus, both universities and companies motivated by different purposes have been stimulated to promote and strengthen their links inside the techno-park.

The forms of linkages between individual firms and universities inside a cluster have been discussed previously. Consequently, the same implies for the techno-parks. Throughout the relationships among universities and companies, techno-parks have a larger indirect impact on the training of skilled labour, the support of scientific networks, the provision of social knowledge, the collective learning and the establishment of informal networks (between firms' employees and employees and academicians) through which tacit knowledge is usually exchanged (EC Report, 2007). Additionally, geographical proximity plays, if not critical, then at least a facilitating role in building and sustaining these relationships.

[13] MIT had been focused on creating relationships with Washington and large, established producers, while Stanford promoted the formation of new technology-intensive firms and collaborative relationships among small firms (Saxenian, 1994).

2.3.3.3. Highly Skilled Labour Force and Mobility of Workers

Highly skilled labour force is perceived as an important precondition for the growth of technology-intensive firms inside the techno-park (Bresnahan and Gambardella, 2004, Saxenian, 1994, Castells and Hall, 1994). As it was discussed in previous section, universities have important role in training the skilled labour force of scientists, engineers, and technicians. According to Castells and Hall (1994:231) the ability to build a local labour market of good-quality engineers and scientist is critical for all start-up technological centres. It can be add to this that local labour market and movement of highly-skilled labour (i.e. highly-skilled employees, researchers, scientists, engineers and managers) among local firms, universities, research institutes and other organizations within the techno-park is important mechanism for collective learning (Keeble and Wilkinson 2000). Moreover, employing the graduates from the near-by university can enhance both transfer of knowledge from university and formation of networks. According to Keeble (2000:210) such intra-regional recruitment diffuses technological and organizational knowledge, strengthen personal networks, and enables new combination of knowledge to be assembled and deployed to develop new innovative products.

In studying inter-firm and firm-university relationships it is, thus, crucial to highlight the importance of mobility of qualified workforce. Mobile workers represent the carriers of knowledge which is an essential type of 'untraded interdependences' between the firms, resulting in the transfer of 'embodied expertise', enhanced informal links and a deepening and broadening of the regional pool of knowledge (Keeble, 2000). Here, universities with their continuous output of young qualified workforce (e.g. scientists, engineers, researchers) may play vital role if cluster firms recruit this labour. On this way, firms help in the dissemination and commercialization of new scientific knowledge derived from university (Keeble, 2000).

Mobility of workers among the firms in the techno-park is seen as a facilitating factor for knowledge spillovers and information sharing, development of the local pool of knowledge, and collective learning. Mobility of workers among the firms can enhance personal relationships that further can be important source of knowledge and technology transfer and sharing. This is due to the fact that each individual

carries information, knowledge, skills and experience acquired at their previous work (Saxenian, 1994) and could potentially utilize it in whichever way she/he likes (Athreye, 2004). Mobility of workers also encourages interactions and linkages between the firms in techno-park. In the Cambridge case for example, it was estimated that 46% of firms reported links with other firms because of personnel that had moved between firms (Keeble 2000, Athreye, 2004). Further, 77% of these firms said that these links were important or crucial to the firm's development (Keeble 2000, Athreye, 2004:149). In the same manner, mobility of workers in Silicon Valley was so frequent that it become not just socially acceptable, but the norm (Saxenian, 1994:34). Moreover, in Silicon Valley example, mobility of people led not just to the strengthening of the networks among the firms but to the accelerated diffusion of the technological capabilities, skills, information and know-how within the region (Saxenian, 1994). Shared technical culture and loyalty to network became indirect products of the workers mobility in Silicon Valley.

In addition, new spin-offs are one type of mobility of workers, as discussed previously. Here, entrepreneurs with research, engineering, or managerial know-how take ideas, expertise or potential products which they have developed in a 'parent' company (or university) and establish a new business inside the techno-park in order to further develop and exploit them (Keeble, 2000: 207). By leaving their existing firms to establish new ones in order to exploit a new technology, innovation or market opportunity, these individuals diffuse high-level expertise and competences inside techno-park, thereby developing the local pool of knowledge (Keeble, 2000: 207). The Cambridge case also showed that a large proportion of firms spun out by former employees continued to maintain formal and informal linkages with the parent firm (Athreye, 2004:149).

Thus, mobility of the workers within techno-park results in the transfer of 'embodied expertise', enhanced informal links and inter-firm networks inside techno-park, and a deepening and broadening of the regional pool of knowledge. All of these further contribute to the success of the techno-park and tenant firms shifting innovativeness and competitiveness of the individual firms and region as a whole to higher levels.

2.3.4. Summary

Techno-parks are perceived in the literature as innovation and competitiveness enhancing regional policy tools in contemporary knowledge-based economy. Thus various efforts and policy recommendations were directed to develop and create techno-parks all over the world. Success stories, such as that of Stanford Research Park in the heart of Silicon Valley, have been prime motivator for other regions to emulate the same success. However, not all techno-parks had shown the real effects in the practice. Thus a growing number of researchers in recent years has been exploring this phenomena, providing particular theoretical proposals for policy makers and governments who desire to promote regional economic development by setting-up techno-parks. Yet, there is general impression of the confusion in the literature as well as lack of the empirical evidence that would verify all theoretical assumptions behind the concept.

Techno-parks are highly diverse and take considerable time to be fully developed and operational. Having this in mind, in the preceding section, we have discussed some of the most commonly emphasized elements of the techno-park concept in the literature. From theoretical point of view, techno-parks are seen as a form of planned innovative clusters or innovative milieus. They embrace various, geographically concentrated, actors. They provide structural elements which promote a variety of linkages and networks (e.g. between university and industry, inter-firm networks, personal relationships), and which encourage synergy between technology-based firms settled in techno-park. Networks further lead to development of an open, flexible and more innovative environment that can enhance the level of economic activity of tenant firms and of the techno-park as a whole. Techno-parks stimulate R&D; encourage knowledge and technology transfer and diffusion among techno-park actors (e.g. inter-firm exchange of information, university-firm transfer of know-how); generate advanced technological capabilities and regional pool of knowledge; and create environment for higher levels of innovativeness through development of more innovative products and processes.

Here, innovation is viewed as arising from the linkages of the milieu as a whole, rather than from individual firms. Thus techno-parks can be perceived as “innovative

milieu" that perform the role of a system which increases the potential for organizational efficiency within firms. The dynamic environment and cooperative culture of techno-parks may further attract more actors locating their businesses near the park. This may lead to the emergence of an industrial cluster. In such a way, techno-parks create a potential development for the region. (EC Report, 2007). Their impact is therefore evident on different levels, i.e. individual firm, techno-park as a whole, and entire region.

Number of scholars has been conducting different studies aiming at verifying or disproving the positive impact of techno-parks on the performance of new technology-based companies. The conclusion, however, have differed among different authors, with some finding little evidence of direct contribution to innovation from the firms located within the park (e.g. Felsenstein, 1994; Siegel at al., 2003a) and others concluding the opposite (e.g. Ferguson and Olofsson, 2004; Lindelöf and Löfsten, 2002).

Despite various findings available in the literature we argue here that techno-parks, as one form of clustering, provide small technology-intensive firms with the potential of becoming more innovative and competitive in the local and international markets. We argue that geographical proximity of actors facilitate formation of inter-firm and firm-university networks and interactions. Even though innovation linkages do not necessarily need to be spatially constituted, as Castells (1996:390) pointed out:

> "At least in this century, spatial proximity is seen as a necessary material condition for the existence of such innovative milieu, because of the nature of the interaction in the innovation process".

We also argue that small technology-intensive firms with high levels of networking, located in close proximity to each other and to university, have the potential to enjoy the benefits of clusters that were discussed previously in the thesis.

CHAPTER 3

METHOD

This chapter encompasses presentation of the purpose of the field study as well as method and data collection consisting of design and application of the techno-park managers interviews and conducted enterprise surveys.

3.1. PURPOSE OF THE FIELD STUDY

Purpose of the field study, as defined on the beginning of the thesis, is to explore whether there are intensive linkages and networks in the two biggest techno-parks in Ankara: METU Techno-park and Bilkent Cyber-park. More specifically, we examine if tenant firms employee high level of highly-qualified personnel that is highly mobile within a techno-park, whether there are intensive inter-firm networks among the tenant firms, and whether there is high level of firm-university alignment in METU and Bilkent techno-parks. The primary objective of the study is to create adequate policy recommendations directed towards the encouragement and intensification of inter-firm and firm-university networks in the techno-parks in order to obtain maximum benefits of clustering concept.

Techno-parks are seen as innovation-fostering milieus of high-tech enterprises in an attractive physical environment with close links to a university (Vedovello, 1997). Thus, it is one of the most proactive mechanisms for setting up an infrastructure in which inter-firm networks and firm-university interactions are built and strengthened. In this context, it can be said that physical proximity between various actors, as provided by the park, has contributed to the enhancement and intensification of their interaction (Vedovello, 1997). Because of these, and other positive attributes of techno-park concept, techno-parks have been widely used as innovation policy tools for facilitating development and transfer of technology, encouraging inter-firm and firm-university cooperation and, thus, promoting local and regional development.

According to Keeble (2000) regional high-technology clusters are characterized by substantial number of small, new and innovative enterprises which are engaged in technologically-advanced manufacturing and service activities (e.g. computer software and services). Moreover, Keeble and Wilkinson (2000:3) describe terms ''high-technology'', ''technology intensive'' and ''technology-based'' as terms used to refer to firms and industries whose products or services embody new, innovative and advanced technologies developed by the application of scientific and technological expertise. Further, such firms are usually identified in practice by high R&D intensity, as it is the case in METU and Bilkent techno-parks. Special attention in the recent studies is directed towards the small and medium-sized technology-intensive firms. The successful cases manifested high tendency towards the clustering and networking producing, thus, successful results in regard to technology, innovation and ability of collective learning.

Hence, METU Techno-park and Bilkent Cyber-park, as two biggest and the most successful techno-parks in Turkey, are suitable cases for our analysis. Both techno-parks are placed in the close proximity to university, Middle East Technical University and Bilkent University, respectively. Moreover, they are settled in the close proximity to each other. They accommodate firms from high-tech sectors (such as, software development, electronics industry, and other high-tech sectors) where majority of these firms is of small and medium size. Objective and mission of these two techno-parks corresponds to the general premises of the techno-park concept in the literature. Considering techno-parks as important infrastructures in contemporary knowledge-based economy, promotion of these infrastructures has high importance in enhancing firms as well as local competitiveness and innovativeness.

Thus, in the following chapters we will analyze if the firms in METU and Bilkent techno-parks, given inter-firm and firm-university spatial proximity, succeeded to develop dense networks of tight relationships. We will identify whether there are inter-firm networks, in what extent they occur in the studied techno-parks, type of the networks (if identified), and what are the motives for inter-firm cooperation and/or what are the reasons for choosing not to co-operate. We will also investigate structure of the employees in both techno-parks, certain elements of firm-university interaction, and intensity of the mobility of workers. In addition, possible similarities

and connections between two techno-parks will be examined. Results of the field study will be used for testing the validity of hypothesis defined for this thesis. Moreover, this analysis will further shape direction of the policy recommendations aimed at intensification of collaboration among the actors settled in the studied techno-parks. The logical framework for the policy recommendations is developed by the preceding literature survey and will be guide for application of our field study. Certain constraints are expected to be encountered, such as lack of data, or questions on the accuracy and recentness of the data. More specifically, constraints such as time, language and inability to access certain documentation available in Turkish language, firms' limited openness and less positive attitudes towards this kind of study, and exclusion of certain sectors (such as defence sector) are other factors that will influence our research and policy-making process.

Additionally, we propose that techno-park environment eases establishment of inter-firm and firm-university networks. Dense networks of connections further allow small, technology-intensive firms settled in the techno-park to innovate and thrive by their links to other organizations (Malecki and Veldohen, 1993). In the same manner, we argue that internal co-operation inside the techno-park, and external networks with organizations from near-by techno-park, will enable firms to capture benefits of the clustering concept. Our policy recommendations, as final part of the thesis, will be based on our state of the art by using knowledge framework and our personal creativity, and will be in harmony with the logical framework and results of the field study.

3.2. METHOD AND DATA COLLECTION

As stated earlier, application of the field study aims at discovering existence of dense inter-firm and firm-university linkages in METU Techno-park and Bilkent Cyber-park. Thus, process of data collection was directed in that course. Collected data will further be analyzed and results will be used to test validity of hypotheses of the thesis and will be considered for the policy recommendations.

Automatically, boundaries of our research are these two techno-parks in Ankara. In both techno-parks all sectors were included in the survey except defence sector.

Defence sector was excluded on the beginning of this thesis as it was assumed that firms from this sector will not be willing to share the information. Thus, excluding defence sector, METU Techno-park and Bilkent Cyber-park are mainly constituted of small and medium, technology-intensive firms that carry on R&D function and that operate in the high-tech sectors (such as, software development, electronics industry, and other high-tech sectors).

Inside these boundaries, data was collected at two different levels: firm level and techno-park level. At the firm level, data was collected by face-to-face questionnaires with the individuals familiar with and capable of answering questions asked in the questionnaire. The same procedure was done in all surveyed companies. At the techno-park level, face-to-face interviews were undertaken with the qualified representatives of the techno-parks' Management Company. Apart from the general background and contextual information, questions (both in questionnaires and interviews) were designed in order to identify existence and frequency of inter-firm networks; university-firm linkages; structure of employees and inter-firm mobility of workers; as well as types of co-operation, motives for cooperation or reasons for non-cooperation. These areas, intended to be identified by our survey, are in harmony with logical framework set up by literature review. Sample of questionnaire and interview questions can be seen in the Appendix B.

Before the field study and data collection, certain arrangements and preparations were needed. This involved defining the purpose and objectives of the field study as well as setting up a logical framework. Afterwards, methodology for collecting and analyzing the data obtained through field survey was chosen. The detailed methodology and information about survey is as follows:

- The Sampling Group for the field survey has been determined. Sampling Group is comprised of firms in METU and Bilkent techno-parks. There was no sector selection (except earlier mentioned exclusion of defence sector). The sectors such as, IT, Electronics, Biomedical, Medical, Tissue engineering, Consultancy, Satellite, Engineering mechanical systems, Aviation, Biotechnology, Geo-science, E-learning, and many others, are included. All of these sectors are indeed the high-tech sectors. According to the nature of techno-park firms and their R&D intensity, units of analysis are

defined as technology-intensive firms, which is in harmony with the logical framework generated for the field survey.

- After the Sampling Group was determined, representatives of both techno-parks' Management Companies were informed about survey taking place. Management Companies then provided the list of the firms that were interviewed. Firms were randomly chosen and each firm was informed about the survey by Management Company.
- A total number of 70 firms in both techno-parks are successfully interviewed. From this number, 36 firms were interviewed in METU Techno-park and 34 firms in Bilkent Cyber-park.
- Two representatives of techno-parks' Management Companies were also interviewed. In METU Techno-park, interview was conducted with Ms. Canan Sandıkcıoğlu (Director, International Projects) due to the absence of Mr. Mustafa Kiızıltaş (Ac. General Manager) during the period of time when interview took place. In Bilkent Cyber-park interview was conducted with Ms. Yasemin Eda Erdal (Business Development Specialist). Interview questions were designed in advance and each interviewee received them before the interview took place, and thus he/she could become familiar with the topics of discussion.
- Questionnaires and interviews were conducted face-to-face during the period between 1st of June 2008 and 1st of March 2009. This long period is due to interviewer's periodical absence from Ankara and occasional visits to Turkey. During this period, more than 85 firms were visited, but only 70 questionnaires are chosen as relevant.
- Non-responses occurred mainly in the METU Techno-park (with only a few cases in Bilkent Cyber-park) due to the unwillingness of firms to dedicate their time and effort in order to participate in the survey. The most often heard reasons were "policy of our firm do not allow us to participate in any kind of surveys", or "we have certain quota of surveys that we participate in yearly, and our quota is already fulfilled".

As mentioned above, besides some documented information in public statistics and reports about METU and Bilkent techno-parks, the main source of information in this field study is gathered from face-to-face questionnaires undertaken in firms of two techno-parks and interviews with two representatives of the techno-parks'

Management Companies. This kind of face-to-face contact proved as highly beneficial due to the fact that in some cases information collected was more than simple answer on the survey's questions. This kind of informal conversations helped us in forming certain assumptions and gathering information that we would not be able to obtain on the formal way.

Moreover, majority of the data collected through the surveys is qualitative in nature combined with small number of quantitative data. Type of questions used in the questionnaires for firms were "close-ended questions". On the other side, type of questions in the interviews was "open-ended questions". Interviews with the representatives of the techno-parks Management Companies were primarily conducted in order to gain an understanding of METU and Bilkent techno-park Management Companies and their position and attitude towards the inter-firm networking and university-firm relationships. This will further help us in determining if the studied techno-parks offer potential for networking to their tenant firms; whether they support university-firm interactions; and if these infrastructures have potential of becoming successful high-tech regional clusters.

The questionnaires designed for conducting the survey among the firms, embrace following categories: general information about the surveyed firm; information about the employees; and information about the cooperation between the firms. More specifically, data collected by questionnaires will be used for designing the policy recommendations in the following way:

- *General information about the surveyed firm*: to determine sector, structure, size and age of the METU and Bilkent techno-park tenant firms. This data will help us in determining if the profile of the METU and Bilkent techno-park firms corresponds to the general conception of the techno-parks and high-tech clusters in general. Moreover, this information will be compared to some documented information of studied techno-parks in order to determine consistency of our survey.
- *Information about employees*: to identify structure of the firms' employees by exploring level of education of the firms' personnel; to determine firm-university relations in the sense of employing university's graduates; to determine level of mobility of workers inside the techno-park as well as among two studied

techno-parks; and to identify rate of spin-offs from existing firms. These data will further be used for testing the validity of hypotheses 1, 2 and 3.

- *Information about the cooperation between the firms*: to determine level of inter-firm cooperation inside METU and Bilkent techno-parks. More specifically, this data will be used to determine type of cooperation among the tenant firms, reasons, frequency, and importance of cooperation for each firm interviewed. On the other hand, particular information gathered from this category of questions will be used to determine why firms in METU and Bilkent techno-parks do not cooperate, and, even though they do not collaborate, how beneficial they perceive networking with the other firms. Analyzing information from this category of questions will be essential for design of policy recommendations. Moreover, these data will further be utilized for testing validity of hypotheses 3 and 4.

Besides, data collected from our survey will be used to analyze each techno-park separately. Some particular comparative analysis of two techno-parks will be presented. Afterwards, two techno-parks will be jointly analyzed.

After the data was collected, the data-analyzing process was conducted in order to bring meaning to the mass of collected data as follows:

- Interview transcripts and questionnaires were systematically organized;
- Data were selected and simplified;
- Classification and generation of the categories, themes and patterns regarding the topic of the study;
- Summarization and tabulation of collected data in order to simplify interpretation and display of data.

Furthermore, analytical software SPSS is used for statistical analysis of collected data. Statistical and descriptive analysis of the information collected throughout the questionnaires and interviews provide the basic and general indicators about the mobility of labour, inter-firm and firm-university relationships. Hypotheses defined on the beginning of the thesis will be tested with empirical results of our field study. Policy recommendations will be the last part of our field study and will consist of defining the specific policy goals and the proposals of policy instruments to achieve these goals.

CHAPTER 4

RESULTS

This chapter, as a first phase of our field study, embraces testing the validity of our hypotheses in the geographical area within the boundaries of two techno-parks in Ankara – METU Techno-park and Bilkent Cyber-park. Results of our field study are in accordance with the logical framework of the clustering, networking and techno-park concepts presented in the literature review of this thesis. The descriptive part of the following analysis starts with short review of techno-parks in Turkey, and METU and Bilkent techno-parks respectively. This phase is then followed by analysis of inter-firm and firm-university linkages in the METU and Bilkent techno-parks. The descriptive part will be completed by in-depth analysis of the questionnaires and interviews conducted. The relevant background information necessitated for descriptive stage, together with all theoretical concepts, is provided in previous chapters.

Findings from this chapter will further present essential information for the identification of policy direction, design of policy recommendations and policy instruments using clustering and networking approach.

4.1. TECHNO-PARKS IN TURKEY

In Turkey idea of establishing techno-parks emerged in the ‘80s. However, only in the 1998 the first techno-parks in Turkey were approved: Tubitak-MAM and METU Technopolis (Kızıltaş, 2006). Utilization of techno-parks in Turkey, like in many developing countries (e.g. China, India, Taiwan, Singapore, etc), is perceived as primary strategy for:

- Promoting R&D and transfer of technology,
- Reducing brain drain by providing employment of high-skilled IT and R&D employees,

- Attracting foreign direct investments and generating foreign exchange through export of R/D products,
- Generating sustainable economic growth and local know-how (Atilla, 2004).

In order to promote the establishment of techno-parks under the guidance and lead of university (or other research institutions) certain legislations were made by the Ministry of Industry and Trade (Atilla, 2004). Thus, in 2001 techno-parks in Turkey obtained the current legal framework that was established by the ‘’Technology Developments Zones – TDZ Law’’, law number 4691 (Kızıltaş, 2006). In accordance with this law, techno-parks are established as a site where academic, economic and social structures are integrated. Involvement of a higher education or research institution as a founder is a mandatory requirement by the law (Atilla, 2004). As a result, majority of the techno-parks in Turkey is located on university campuses.

Through ensuring cooperation among universities, research institutions and the production sector, the aim of the law (according to Article 1) is:

- to generate technological information in order to provide the national industry with an internationally competitive and export-oriented structure;
- to introduce innovations in products and production methods;
- to raise the quality or standard of products;
- to increase productivity;
- to decrease the costs of production;
- to commercialise technological knowledge;
- to support technology-intensive production and entrepreneurship;
- to enable small and medium-sized enterprises to adapt to new and advanced technologies;
- to create investment opportunities in technology intensive areas by taking into account the decisions of Supreme Council of Science and Technology;
- to create job opportunities for researchers and qualified persons;
- to assist technology transfer; and
- to provide the technological infrastructure which will accelerate the entry of the foreign capital which, in turn, will provide high/advanced technology.

In sum, techno-parks’ aim is directed towards high-tech companies to develop technology and software and carry out R&D by utilizing the facilities of a university

(or other R&D institutes) of which it must be located in or near to, to convert technological innovation into products or service and to encourage direct foreign investment. Hence, with this law, companies are encouraged to invest more in R&D and software development through tax incentives.

Particular exemptions and tax incentives provided by the law, and valid till the end of 2013, encompass:

- Income and corporate tax exemptions for the operating company,
- Income and corporate exemptions for income from software development and R&D activities,
- Income tax exemptions for the salaries of the researchers, software development stuff and R&D personnel,
- VAT exemptions for the software development activities in the zone,
- Sponsored aid and donations for individuals and institutions having R&D activities in the zone,
- Right of recruitment of individuals from government research organizations or university,
- Legal permission for academicians to establish firms, or become partner of existing firm in the zone, to commercialize their academic work (Atilla, 2004).

Institutions providing R&D financing for the firms located in the techno-parks in Turkey are:

- Technology Development Foundation of Turkey (TTGV),
- Scientific and Technical Research Council of Turkey – Technology Monitoring and Evolution Board (TÜBITAK-TIDEB),
- Ministry of Industry and Trade / Small and Medium Size Industry Development Organization (KOSGEB),
- International Resources, such as 6^{th} and 7^{th} Framework Program, and so forth (Atilla, 2004).

Currently, there are 33 techno-parks established in Turkey from which only 19 are operational (Can, 2008). The most active techno-parks in Turkey are: METU, Bilkent, Hacettepe, GOSB, Tübitak-MAM, and ITU ARI. Their location is shown in the Figure 3. While the ownership structures of the techno-parks in Turkey vary, all

of them have a mixture of private, public and non-governmental partners (Can, 2008).

Figure 3. Location of the most active techno-parks in Turkey: 1) Bilkent, 2) METU, 3) Hacettepe, 4) GOSB, 5) Tübitak-MAM, and 6) ITU ARI

Source: adapted from Atilla (2004)

According to Can's (2008) survey of operational techno-parks in Turkey, three main goals of almost all of the techno-parks are: improvement of university-industry collaboration; commercialization of new technologies; and support of information and technology based entrepreneurship. In the same survey, Can (2008) found that techno-park managers perceive the following benefits that techno-parks provide to their tenant firms: 1) opportunity to collaborate with a university; 2) opportunity to benefit from tax exemptions and tax breaks; 3) good location; 4) prestige; 5) relations and collaborations with other tenant firms; 6) infrastructure; and 7) business support services.

From 2008, new Turkish law (law number 4691) that extends public support for R&D activities to firms with more than 50 R&D employees even if they are not located in techno-parks became effective (Can, 2008). It is believed that this new law will make techno-parks less attractive for bigger firms, pushing techno-parks to find ways of attracting tenants through techno-park services and opportunities for collaboration rather than being able to rely largely on tax incentives (Can, 2008).

4.1.1. METU Techno-park

Studies about the METU Techno-park project, also called as METU Technopolis or METUTECH, were initiated in the 1987 with main objective to support the formation and development of technology-intensive using-producing firms to ensure the development of technology, and to maximize the university-industry cooperation. The management company of METU Techno-park – Teknopark Inc. was founded in 1991. Shareholders of Teknopark Inc. are The Middle East Technical University Development Foundation, Ankara Chamber of Industry, Bleda Co, EBI Co, Ortadoğu Yazılım Co., and Middle East Technical University. The first buildings of METU Techno-park were put into service in 2000 and 2001 (Kızıltaş, 2006). In the year 2001, when the Law of Technology Development Zones no. 4691 was issued, METU Techno-park was declared as a "Technology Development Zone" by the law (Kızıltaş, 2006).

METU Techno-park is characterized as the largest and the most successful techno-park in Turkey, and it is located in METU Campus. Among 216 firms, 90% of which are SMEs, company profiles are mainly based on software development and electronics industry (see Figure 4). METU Techno-park companies employee 3730 personnel, 3133 of which are the researchers (from Figure 5 it can be seen that 86% of the total staff are university graduates and 23% of which have Ms, MBA, or PhD degrees).

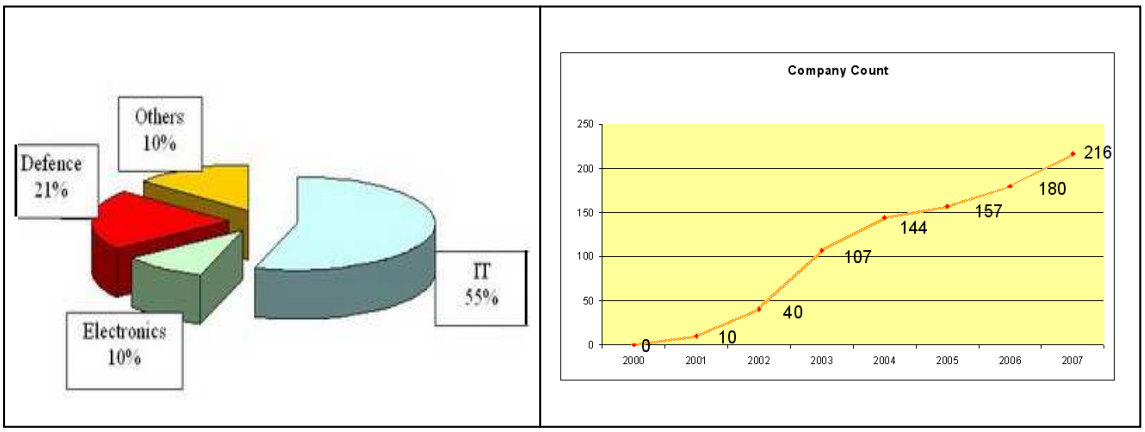

Figure 4. Distribution of Companies according to their activity areas and Company Count

Source: Adapted from Technopark Inc. (2007)

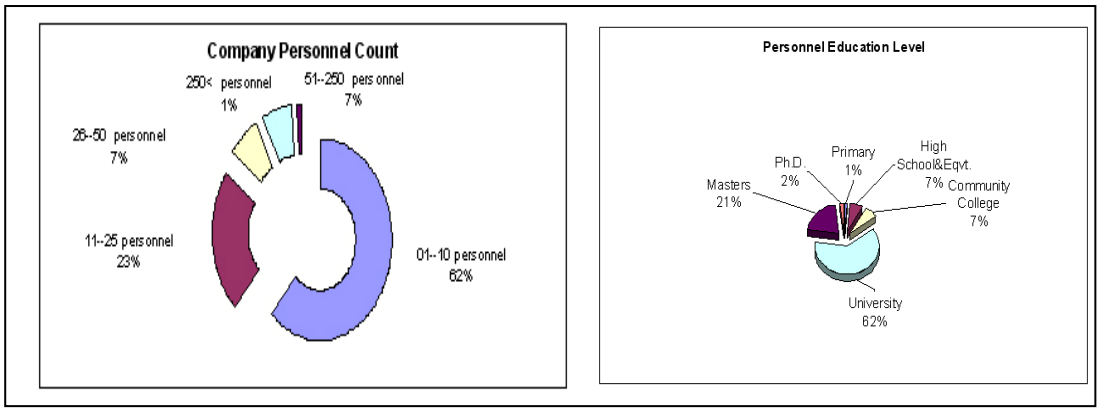

Figure 5. Company Personnel Count and Personnel Education Level

Source: Adapted from Technopark Inc.(2007)

Key objectives of the METU Techno-park are as follows (adapted from Technopark Inc, 2009):

- *To enhance international collaboration and networking;*
- *To encourage and support entrepreneurship and innovation;*
- *To assist in regional RTD and to be one of the elements of sustained regional development;*
- *To initiate and maintain the collaboration between industry-university;*
- *To assist in transforming the university's research infrastructure and information accumulation into economic value through spin-offs;*
- *To prepare a suitable environment for technology transfer and foreign direct investment;*
- *To create employment for qualified human resources;*
- *To promote university based start-ups and spin-offs.*

In general, the main aim of METU Techno-park is twofold: to ensure the development of technology through formation of high-tech tenant firms; and to support the creation of synergy between the partners through activities increasing the cooperation among university, industry and infrastructural and structural opportunities developed for academicians, researchers and companies.

Moreover, services of METU Techno-park provide opportunities for tenant companies through a variety of services. These services can be categorised under three different program types: training programs, consultancy services, and value

added services. Training programs comprise of the 75% of the total amount of value added services, whereas consultancy services on international marketing, technology transfer, IPR (Intellectual Property Rights), international legal advising, and funding comprise of the 15% of these services. Other areas of services include events, travel, catering, etc.

Site management services provided by METU Techno-park include facility management, data and telecommunication services, security, landscaping, management services, etc.

METU, as the leading research university since 1950's, offers variety of physical and human resources to METU Techno-park's tenant firms. The experienced work force of METU, 2500 academics, 23.000 students, powerful research infrastructure of 40 research centres, and almost 365 university laboratories is perceived as significant factor that facilitate the establishment of strong cooperation between university and firms. Close geographical proximity to the researchers and research opportunities which are the main components of R&D studies together with the utilization of existing facilities such as laboratories and library are provided by techno-parks location inside the university campus. Thus, R&D infrastructure, knowledge pool and experienced expert team of METU play an important role in creating strong links between the techno-park tenant companies and the university.

Additionally, the personnel of the tenant firms benefit from social and cultural activities provided by METU and used by the personnel and students of METU, such as, banking, shopping centre, restaurants, culture and convention centre, closed and open swimming pool, dry-cleaning, gymnasium, etc.

It is important to mention here that primary criterion for selecting the persons, institutions and tenant firms depends on their contribution to the METU Techno-park's vision of being one of the leading technology development regions by providing products and services of high value that rest on high technology in which firms and entrepreneurs exist in a competitive environment, through benefiting from METU's research capacity and information pool. Thus, the profile preferred for tenant companies is: innovative-technology based, and inclined to cooperate with the other parties, primarily with the university. Being involved in research and

development activities, and possessing reasonable amount of managerial, financial, and human resources are preliminary qualifications that are expected from METU Techno-park. In the selection of the tenant companies, sectors were determined taking the industrial profile of Ankara into account along with the resources of the university and the competitive advantages it possesses. Hence, ICT, electronics, aerospace, environment, biotechnology, nanotechnology, advanced materials are the privileged sectors for METU Techno-park.

Considering characteristics and objectives of the METU Techno-park, as well as METU University's research capacity and information pool combined with the innovative capacity of entrepreneurs, METU Techno-park became a model that is appropriated by many newly developing techno-parks in Turkey.

4.1.2. Bilkent Cyber-park

Bilkent Cyber-park, also known as Ankara Cyber-park, is a science and technology park established jointly by Bilkent University and its associate Bilkent Holding (which has many companies with software development and R&D functions). Bilkent Cyberpark Inc., was founded in 2001 and announced as ''Technology Development Zone'' in 2002 by the law.

Bilkent Cyber-park is established within the Bilkent University campus area and it is one of the fastest-growing techno-parks in Turkey. Its geographical proximity to two other prominent universities, METU and Hacettepe, is perceived as a great advantage for the Cyber-park members. Bilkent Cyber-park accommodates approximately 160 technology-based tenant companies. These companies mainly operate in IT sector (software development and R&D), while there are companies operating within areas such as electronics, telecommunication, aerospace technologies, environmental technologies, biotechnology and nanotechnology. Great majority of the tenant firms is of small and medium size. Cyber-park employees approximately 2300 personnel, 1000 of which is R&D personnel.

Key objectives of the Bilkent Cyber-park are (adapted from Cyberpark Inc, 2005):

- *To enhance technological and scientific advancement;*
- *To increase number of R&D studies and R&D return rates;*
- *To promote start-ups;*
- *To support SMEs;*
- *To encourage formation of high technology based companies;*
- *To attract more foreign investment;*
- *To increase export potential;*
- *To generate more jobs for high qualified graduates and researchers;*
- *To lessen brain migration;*
- *To provide more commercially oriented courses;*
- *To contribute to the creation of synergy;*
- *To generate less costly production;*
- *To provide better living standards;*
- *To create environment for better workplaces;*
- *To enhance use of benchmarks to upgrade performance.*

In general, the aim of the Bilkent Cyber-park is threefold (adapted from Cyberpark Inc, 2005):

- *To provide a new model for interaction between the universities (mainly Bilkent University at the first stage) and businesses on the Cyber-park, through the greater involvement of academics, students and research staff. In turn, this will enable universities to become more entrepreneurial in teaching, research and technology transfer activities, and the businesses to become more innovative through the application of new technologies and knowledge;*
- *To create a cluster of technology-intensive national and international companies, research and academic institutions by bringing them together into an ecosystem that promotes and creates new types of synergies between the scientific and the entrepreneurial communities; and*
- *To promote the birth and growth of new companies and institutions that contribute to advances in technology development and export potential of Ankara and Turkey.*

Furthermore, Bilkent Cyber-park's main service is to provide appropriate office, industrial and storage areas for to technology-intensive tenant companies. Along with

this, Cyber-park provides other site services such as, site management, security, medical care, postal services, insurance, financial services, IT services, congress, conference and exhibition opportunities, and so forth.

Additionally, Cyber-park provides a variety of consultancy and training programmes to the tenant companies. These services are provided through support units such as, Incubation Centre, Consultancy Unit for Access to the Financial Resources and Grants, EU Centre, Consultancy Unit for Access to Venture Capital, and Life-Long Education Centre.

Close geographical proximity to the Bilkent University, as the best private university in terms of scientific research and technology development capacity in Turkey, offers advantage of easier access to the university's facilities (library, laboratories, etc.) and human resources. Academics and research personnel, knowledge pool and R&D infrastructure of Bilkent University play an essential role in generating robust links between the Cyber-park tenant companies and the university.

In addition, Bilkent Cyber-park provides various social and cultural facilities to the tenant firms. Hence, members of the tenant companies can benefit from the socio-cultural opportunities such as, shopping and catering centres, sports, travel agencies, accommodation and other facilities. On this way, Bilkent Cyber-park aims at improving living standards and social life of its employees.

In Cyberpark, primary criterion for selecting the tenant companies is mainly based on the request that firms, and/or the related units of the firms, carry on the R&D activities based on information and technology development. Some of the main areas encompass Software Development; Multimedia Technologies; Wireless and mobile communication systems; Satellite communication and microwave technologies; Space and aviation technologies; Computer, communication and periphery equipments production; Biomedical engineering and medical equipments production; other Electrical and electronical tools and systems production; Biotechnology and bioengineering; and many others. Other than the firms functioning in the mentioned areas, Cyber-park support companies like banks, investment firms, consulting and training agencies.

Bilkent Cyber-park is also said to be the fastest-growing techno-park in Turkey. Besides, Bilkent Cyber-park set up high aims for its future development. The most striking one is its vision to extend over time, to cover several universities and research institutions, and, thus, to evolve into a Cybercity serving the entire Ankara metropolis. In other words, Bilkent Cyber-park in the future intends to create a 'Silicon Valley' of Ankara.

4.2. ANALYSIS AND RESULTS

After reviewing the basic characteristics of METU Techno-park and Bilkent Cyber-park it can be concluded that two techno-parks are to a great extent alike. Their objectives and structure correspond to the basic concept of techno-parks given in the logical framework of this thesis. Both techno-parks are deliberately planned areas with the main objectives to support: university-industry relationships; formation of the technology-intensive enterprises; birth of spin-offs; creation of networks among the tenant firms; generation of new jobs for highly qualified labour pool; and growth of R&D activities. Along with these objectives, both techno-parks directed their efforts towards the promotion of technological innovation, and generation of scientific synergy and economic productivity. Both techno-parks are placed in the university's campus and are mainly comprised of small and medium technology-intensive enterprises. Close geographical proximity to two best universities in Turkey is perceived as a great advantage for the creation and sustainability of university-industry collaboration. Management Companies of these techno-parks provide variety of services that aid development of technology-intensive tenant enterprises. Having this in mind, we argue that METU Techno-park and Bilkent Cyber-park offer to their tenant firms advantages of the techno-park concept that are discussed in the literature framework. In the accordance with the established logical framework, we also argue that dense networks among the tenant firms as well as intense university-firm collaboration among these geographically close actors can generate clustering benefits for the tenant firms. Moreover, we argue that close geographical proximity of METU Techno-park to Bilkent Cyber-park, as well as their close proximity to the Hacettepe Techno-park, can facilitate the formation of 'Cyber-city' or 'Silicon Valley' of Ankara. For this to happen, efforts

from both techno-parks, their mutual collaboration, and right policy tools must be carefully generated and implemented.

This thesis presents one of the basic steps in analysing METU and Bilkent techno-parks in the sense of their potential for forming strong cluster. The results of the collected data throughout the field study will be used in testing hypotheses of the thesis. Additionally, these results will be used as a guide for policy recommendations.

4.2.1. General Information and Characteristics of the Surveyed Firms

Before testing the hypotheses we will present general elements and structure of the surveyed technology-intensive firms from METU and Bilkent techno-parks. Thus, Table 3 summarizes the number and percentage of the surveyed firms in the both techno-parks. Tables 4 and 5 summarize the results from the question 2 in our questionnaire (see Appendix B.1), while Tables 6 and 7 review the results of the questions 3 and 5 respectively.

At the time of the survey, it was projected that METU Techno-park accommodates 171 enterprises (excluding 20% of the firms that belong to defence sector), and Bilkent Cyber-park is being host to the 160 enterprises. Total number of 70 firms has been surveyed, out of which 36 firms belong to METU Techno-park and 34 firms to the Bilkent Cyber-park. Thus, the sample of the surveyed firms counts for 21% of the total number of firms in both techno-parks (see Table 3) which is quite a representative sample.

Table 3. Total number and Number of surveyed firms in studied techno-parks

	Total number of firms	**Number of surveyed firms**	**Percentage of surveyed firms (%)**
METU Techno-park	171	34	21
Bilkent Cyber-park	160	36	21
TOTAL (METU and Bilkent):	331	70	21

From the 36 surveyed firms in the METU Techno-park, 69% of the firms operate in the IT and/or Electronics whereas 31% of the firms operate in other areas such as, SLU development and R&D, engineering R&D, computer science, engineering mechanical systems, aeronautical and turbo-machinery, aviation, biotechnology, software education and design, electro-optics, geo-science, e-learning, computer aided engineering, and consultancy. In the Bilkent Cyber-park, tenant firms mainly belong to IT and Electronics. Of the total number of surveyed firms in the Bilkent Cyber-park, 76% operate in the IT and/or Electronics while 24% belongs to the other areas such as, construction cement, aerospace technologies, biomedical, medical, tissue engineering, consultancy and satellite (see Tables 4 and 5).

In METU Techno-park 80% of surveyed firm is founded after the year 2001. In Bilkent Cyber-park 70% of surveyed firm is founded after the year 2001 (see Table 6).

Considering organizational structure of the firms (see Appendix C for more details), in METU and in Bilkent techno-parks majority of the surveyed tenant firms has Family-Limited (Ltd.) structure (70% and 65% respectively). In the METU and Bilkent techno-parks majority of the surveyed firms either does not have mother firm or has less than 50 employees in the mother firm (see Appendix C for more details). In METU Techno-park 75% of the surveyed firms has less than 10 employees and in Bilkent Cyber-park almost the same percentage of the firms – 74%, has less than 10 employees (see Table 7). Most of our sample, in fact, belongs to micro and small enterprises rather than SMEs.

Table 4. Number of firms operating in IT, Electronics, and IT&Electronics in studied techno-parks

Total number of surveyed firms: 70				
	Only IT	**Only Electronics**	**IT&Electronics**	**Total Number of IT&Electronics**
METU T.P.	14	6	5	25
Bilkent C.P.	20	4	2	26
TOTAL (METU & Bilkent)	34	10	7	51

Table 5. Distribution of firms according to areas of functioning in studied techno-parks

Total number of surveyed firms: 70		
	IT & Electronics (%)	**Other areas (%)**
METU T.P.	69	31
Bilkent C.P.	76	24
TOTAL (METU & Bilkent)	73	27

Table 6. Distribution of firms according to year of establishment in studied techno-parks

Total number of surveyed firms: 70			
	Before 2001 (%)	**Between 2001 and 2005 (%)**	**After 2005 (%)**
METU T.P.	20	20	60
Bilkent C.P.	30	35	35
TOTAL (METU & Bilkent)	25	27.5	47.5

Table 7. Size of the techno-parks' firms according to the number of employees

Total number of surveyed firms: 70			
	Till 10 employees (%)	**Between 11 and 50 employees (%)**	**Above 50 employees (%)**
METU T.P.	75	19	6
Bilkent C.P.	74	20	6
TOTAL (METU & Bilkent)	74.5	19.5	6

From the questions that refer to general information about the surveyed firms in our questionnaire (questions 1 to 5) the following characteristics can be summarized:

- The profile of the majority of the METU Techno-park's tenant firms (69%) is based on the IT and Electronics. Similarly, in Bilkent Cyber-park 76% of the firms operate in the IT and Electronics. Here, minor difference between two techno-parks is that in Bilkent Cyber-park greater majority of the firms – 65%

operates in IT. On the other hand, METU Techno-park has slightly higher percentage of the variety of other areas that technology-intensive tenant firms operate in. These sub-sectoral characteristics of the tenant firms obtained from our survey correspond to the documented data, discussed earlier in this section, regarding the main areas in which tenant firms operate in the METU and Bilkent techno-parks.

- Majority of the firms in METU Techno-park and Bilkent Cyber-park (80% and 70% respectively) was founded after year 2001. This fact matches the rapid development of the both techno-parks after the year 2001. However, our sample illustrates that METU Techno-park has higher rate of the firms that have been founded after the year 2005 than Bilkent Cyber-park (60% and 35% respectively) because of the frequent enlargement in the last years.

- In METU Techno-park and Bilkent Cyber-park common organizational structure of the tenant firms is Ltd. (70% and 65% respectively). Local partner excluding Family (A.Ş.) accounts for 25% and 24%, while Foreign partner or Liaison office of foreign company accounts for 5% and 3% in METU and Bilkent techno-parks respectively. In Bilkent Cyber-park 6% of the surveyed firms belong to the other organizational structures, namely Association and University Research Centre, whereas among the sample of the firms surveyed in METU Techno-park there was no other organizational structures.

- The results of the question 5a in the questionnaire indicate that the great majority of the total number of surveyed firms (85%) in both techno-parks is in the category of the small firms considering the number of employees in mother firm or the existence of the mother firm. Out of 31% of the firms that have mother firm in both techno-parks, only 3% reported that their mother firm has more than 250 employees, and 12% reported that their mother firm has between 51 and 250 employees. In the same manner, results of the question 5 demonstrate that 94% of the firms can be considered as of micro and small size regarding the number of employees in the techno-parks firms. Only 6% of the surveyed tenant firms in both techno-parks reported to have more than 50 employees. Hence, surveyed firms can be considered as small and medium size enterprises. This statement is in the harmony with the documented

characteristics of the tenant firms in METU and Bilkent techno-parks. Additionally, the cross-tabulation analysis from the SPSS statistical programme, indicate that from the whole number of tenant firms that has more than 50 employees in both techno-parks, 100% is founded before the year 2001. Also interesting data from the same cross-tabulation is that 91.2% of all tenant firms founded after 2005 in both techno-parks has less then 10 employees.

- Moreover, from the above analysis of the general information about the surveyed firms, it can be concluded that firms in METU and Bilkent techno-parks are much alike. There is very small percentage difference in responses that regard to the questions about areas of functioning, organizational structure and size of the firms. The highest percentage difference can be found in the year of establishment, especially for the firms established after the year 2005 (25% difference for the firms from METU and Bilkent techno-parks), due to the non-synchronization of enlargement decisions of two techno-parks. However, this dissimilarity is not considered as a crucial factor that would distinguish two techno-parks. Hence, despite slight percentage variations regarding the general information and data about the surveyed firms from both techno-parks, the tenant firms are perceived to have the same characteristics. This fact will allow us to apply some of the analysis on two techno-parks as a whole along with the individual analysis for each of the surveyed techno-parks.

4.2.2. Testing the Hypotheses

According to the previous analysis of the METU and Bilkent techno-parks, it can be concluded that both techno-parks has the characteristics and objectives that are in concordance with the techno-park concept as set up in the logical framework of this thesis. Moreover, our survey has showed that the tenant firms of the METU and Bilkent techno-parks are in the category of the technology-intensive enterprises (according to the areas of their functioning) and are of the small and medium size (according to the number of their employees).

After analyzing the basic information about the tenant firms' in both techno-parks, we can continue with testing the hypotheses that were defined previously.

Testing the Hypothesis 1

In order to test this hypothesis, we will use results of the questions from part II of our questionnaire (e.g. questions 6, 7, 8, 9, 11, 12, 13 and 14). The theoretical background for the hypothesis 1 is discussed previously in the logical framework of this thesis.

The Hypothesis 1 is as follows:

If small technology-intensive firms are settled in the techno-park as particular form of cluster then due to the proximity to university these firms will employee high level of highly-qualified personnel that is highly mobile within a techno-park.

Results from the survey indicate that there is not high level of the high-qualified personnel i.e. personnel with PhD and MS degrees, and majority of the employees is with the BS level of education (see Table 8). These results of our survey are also consistent with the documented data about METU and Bilkent techno-parks. However, this shows us that there is low level of interaction between tenant firms and highly qualified labour. Yet, this could be enhanced in the cooperative environment of the both techno-parks.

Table 8. Level of education of the personnel in the tenant companies

Total number of surveyed firms: 70				
	PhD personnel (%)	**MS/MBA personnel (%)**	**BS personnel (%)**	**High School & Other personnel (%)**
METU T.P.	6	23	59	12
Bilkent C.P.	4	19	61	16
TOTAL (METU & Bilkent)	5	21	60	14

From Table 9, it can be seen that the majority of the personnel in both techno-parks performs R&D function. There is slight percentage difference between METU and Bilkent techno-parks regarding the distribution of the personnel. This dissimilarity is mostly evident in the distribution of R&D personnel (11% difference) and 'other'

personnel e.g. sales, purchase, accounting, secretary, etc. (13% difference). It is important to mention that in the tenant firms, particularly small technology-intensive companies in studied techno-parks, very often it was the case that one person performs two or even three functions. For instance, the most frequent situation encountered was that manager of the company at the same time performs R&D function.

Table 9. Distribution of the personnel in the tenant companies

Total number of surveyed firms: 70				
	Management personnel (%)	**R&D personnel (%)**	**Production personnel (%)**	**Other personnel (%)**
METU T.P.	13	55	23	9
Bilkent C.P.	15	44	19	22
TOTAL (METU & Bilkent)	14	48	21	17

One more related point that was surveyed (question 8 of the questionnaire) regards the problems of tenant firms to find and employ highly qualified labour. Table 10 illustrates the results. Given the close geographic proximity to the university in the case of both METU and Bilkent techno-parks, it is quite surprising that in both techno-parks more than half of the surveyed firms expressed having problems in finding highly qualified labour.

Table 10. Problems in finding the professional employees in the tenant companies

Total number of surveyed firms: 70		
	Having problems in finding professional employees (%)	**NOT having problems in finding professional employees (%)**
METU T.P.	53	47
Bilkent C.P.	60	40
TOTAL (METU & Bilkent)	56	44

Statistical analyses and cross-tabulation (analyzed through the SPSS statistical software) for METU and Bilkent techno-parks as a whole shows us that (see Appendix D, cross-tabs 2):

- 83.8% of all tenant firms that expressed problems in finding the highly qualified employees are tenant firms that have less than 10 employees; whereas 13.5% and 2.7% of all tenant firm that expressed problems in finding the highly qualified employees are tenant firms that have between 11 and 50 employees and tenant firms with more than 50 employees, respectively;
- 75% of all tenant firms that have more than 50 employees do not have problems in finding the highly qualified employees.

These results (question 6 – 8) indicate that small technology-intensive firms from both techno-parks have more problems in finding highly qualified employees in comparing with the middle size (between 11 and 50 employees) and big size (above 50 employees) tenant companies. These results also depict the necessity for small technology-intensive firms inside the techno-parks to develop strong inter-firm and firm-university relationships in order to overcome variety of difficulties such as, the problem of finding the highly qualified workforce.

From the questions 11 to 14 of our questionnaire we obtained the following results:

- From the Figure 6 it can be seen that very small number of the firms in both techno-parks had experience of losing the employee who went to another company located in the same techno-park. The 19 % and 18% of the surveyed firms from the METU and Bilkent techno-parks respectively reported this experience.

Figure 6. Number of METU and Bilkent techno-parks' tenant companies that had/did not have experience of losing employee who went to another company located within the same techno-park

- Very small number of the firms in both techno-parks had experience of losing the employee who went to another company located in the other techno-park (see Figure 7). The 11 % and 12% of the surveyed firms from the METU and Bilkent techno-parks respectively reported this experience.
-

Figure 7. Number of METU and Bilkent techno-parks' tenant companies that had/did not have experience of losing employee who went to another company located within the other techno-park

- Surprisingly, in METU Techno-park none of the firms reported the experience of the employee who left the company and established his own company in the same techno-park. In Bilkent Cyber-park 12% of the surveyed firms reported that they had such an experience (see Figure 8). Thus, Cyber-park is more successful in terms of spin-offs.

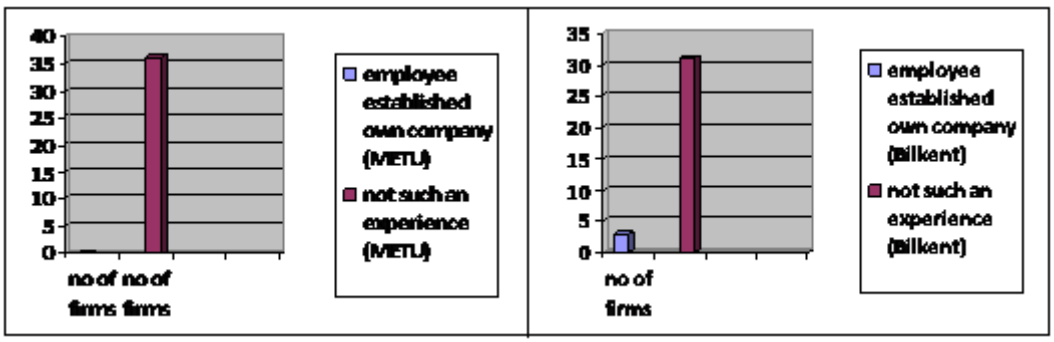

Figure 8. Number of METU and Bilkent techno-parks' tenant companies that had/did not have experience of losing employee who established his own company within the same techno-park

- In METU Techno-park 3% of the surveyed firms reported that they had an experience of the employee who left the company and established his own company in another techno-park. In the Bilkent Cyber-park, this percentage is

slightly higher and amount for 9% (see Figure 9). Thus, Cyber-park is more successful in terms of spin-offs.

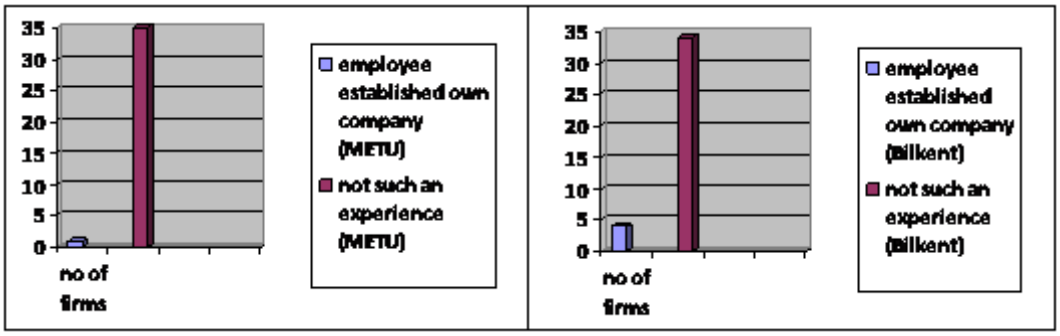

Figure 9. Number of METU and Bilkent techno-parks' tenant companies that had/did not have experience of losing employee who established his own company within the other techno-park

Questions 11 – 14, thus, help us to understand if the surveyed tenant firms from METU and Bilkent Cyber-park had experience of losing the employee who found new job in another tenant company or founded his own company in the techno-park. On the other hand, question 9 indicates if the surveyed firms find their employees from another tenant companies[14].

Table 11. Finding the professional employees from the other tenant companies

Total number of surveyed firms: 70		
	Finding employees from another firms in the same techno-park (%)	**Finding employees from the firms settled in another techno-park (%)**
METU T.P.	3	3
Bilkent C.P.	15	11
TOTAL (METU & Bilkent)	9	7

From Table 11, it can be seen that surveyed tenant firms do not practice employing the workers from another firms located in the same or other techno-parks. Finding employees from the firms settled outside the techno-parks, from the universities or

[14] It is important to mention here, that firms had opportunity of multiple choice in the question 9 of the questionnaire.

finding employees by ‘other’ means (e.g. via Internet) are more common ways of employing personnel in the tenant firms of the METU and Bilkent techno-parks.

These results (question 9, 11 – 14), thus, indicate that there is very low level of the mobility of workers between techno-parks’ tenant companies. Even when the firm reported that they had an experience of employee who had left particular company and found a job in another company within the same or another techno-park, the number of such employees was very few. In the small companies, mostly it was 1 or 2 employees and the maximum number of the 5 of such workers was reported only twice and occurred in the big companies. On the other hand, very few percentage of the surveyed tenant companies practice employment of the personnel from the tenant firms settled in the same or another techno-park. Hence, the mobility of the workers among the tenant companies within the same techno-park (METU and Bilkent individually) and mobility of workers among various techno-parks is neither common nor frequent event. The same can be said for the spin-offs from the existing companies. Percentage of the employees who left their company in METU and Bilkent techno-parks and founded their own firm in the same or another techno-park is even fewer than percentage of the mobility of workers.

Low level of ‘highly qualified workers’, and low level of ‘mobility of workers’ and ‘spin-offs from existing companies’ among the tenant firms in the same techno-park (METU or Bilkent), or among tenant firms settled in the two geographically close techno-parks, implies the following conclusions according to the theory:

- There is no ground for developing informal links and enhancing personal relationships inside the METU and Bilkent techno-parks;
- Knowledge spillovers, information sharing, exchange of tacit knowledge, development of local pool of knowledge and collective learning are not facilitated in the studied techno-parks; and
- Informal interactions and formal linkages among the tenant firms inside the techno-park, METU or Bilkent, as well as interactions and linkages among the tenant firms from different techno-parks, METU and Bilkent, are neither encouraged nor supported.

Testing the Hypothesis 2

In order to test this hypothesis, we will use results of the questions that belong to part II of our questionnaire (e.g. questions 9 and 10). In addition, we will use in here particular answers from the interviews with the techno-parks' managers. The theoretical background for the hypothesis 2 is discussed previously in the logical framework of this thesis.

The Hypothesis 2 is as follows:

If the technology-intensive firms are settled in the techno-park then there will be high level of firm-university alignment.

As it was discussed earlier, METU and Bilkent universities had critical role in development of the METU and Bilkent techno-parks, respectively. Moreover, METU and Bilkent techno-parks are settled in the university campuses (METU and Bilkent University respectively). Consequently, this implies the close geographical proximity between the tenant firms and university. According to our logical framework, geographical proximity of various actors *per se* is not sufficient factor that leads to formation of inter-firm and firm-university networks. Yet, geographical proximity is factor that can facilitate establishment of linkages and interactions among the geographically proximate institutions and enterprises.

By analyzing questions 9 and 10 from the questionnaire, we wanted to observe if the tenant firms in METU and Bilkent techno-parks developed basic linkages with the near-by universities and in what extent. Results indicate the following:

- From the question 9[15] it can be seen that majority of the surveyed firms in both techno-parks prefer to find employees from the near-by universities (see Table 12 and Figure 10). Finding employees from the 'other' sources such as, Internet (Cariyer.net), references from the friends or family, etc., received the highest ranking after the Technical education schools. On the third place, tenant firms from both techno-parks find their employees from the other firms located outside

[15] As mentioned previously, firms had opportunity of multiple choice in the question 9.

the techno-parks. The smallest percentage of the firms chooses finding personnel from the firms settled in the same or another techno-park and from abroad. Analyzing this issue, small difference in the percentages can be seen between the METU and Bilkent techno-parks' tenant firms. Yet, it is not perceived as a great dissimilarity.

Table 12. Ways of finding the professional employees

Total number of surveyed firms: 70						
	Firms in the same techno-park (%)	**Firms settled in another techno-park (%)**	**Firms outside techno-parks (%)**	**Abroad (%)**	**Technical education schools (%)**	**Other (%)**
METU T.P.	3	3	11	/	67	36
Bilkent C.P.	15	11	29	9	50	29

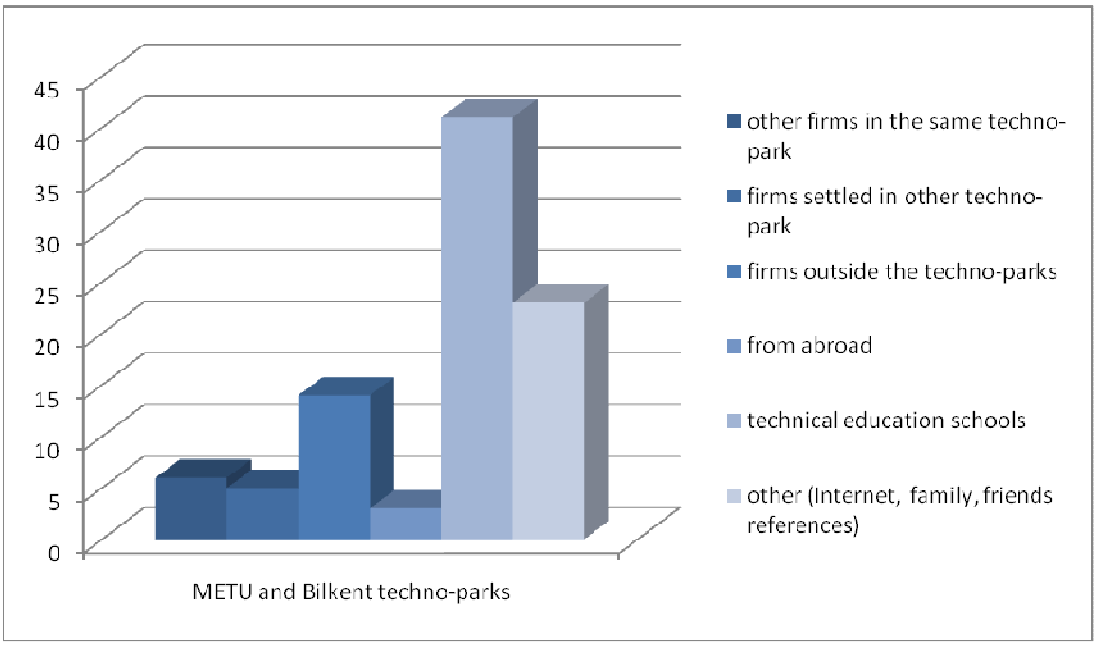

Figure 10. Number of METU and Bilkent techno-parks' tenant companies according to their ways of finding employees

- From the question 10 we observe firms' opinion on how they comprehend the proximity to university. Results indicate that great majority of tenant companies

find it beneficial to be near university in order to access the professional personnel (see table 13). Moreover, 84.6% of the tenant firms that have up to 10 employees from both METU and Bilkent techno-parks find it beneficial to be near university in order to access professional personnel, 85.7% of the tenant firms that have between 11 and 50 employees, and 100% of the tenant firms that have more than 50 employees reported the same opinion (see Appendix D, cross-tabs 3).

Table 13. Being beneficial to the University

Total number of surveyed firms: 70		
	Beneficial to be near university in order to access professional employees (%)	**NOT Beneficial to be near university in order to access professional employees (%)**
METU T.P.	84	16
Bilkent C.P.	88	12
TOTAL (METU & Bilkent)	86	14

From the Interviews with the representatives of the techno-parks' Management Companies (questions 2, 3 and 9; see Appendix B.2), we obtained the following:

- In METU and Bilkent techno-park tenant companies have access to the universities' (METU and Bilkent university respectively) resources, such as employees, laboratories, library, etc. Access to the employees and researchers is not free of the charge, whereas it is possible to have free access to the laboratories. Library is available for every member of the techno-park tenant companies.
- In METU Techno-park, Management Company does not trace how often or at what level tenant firms use university's resources. In Bilkent Cyber-park, according to the information that Management Company has, tenant firms use the library the most often from all available university's resources.
- METU and Bilkent techno-parks' management companies maintain the tight cooperation with the academicians from the universities (METU and Bilkent university respectively). Management companies are helping academicians to start their own companies. Management companies work on connecting

academicians with the tenant companies that need professional consultancy or that search to employ such a high qualified personnel. By doing this, management companies of the studied techno-parks also aid academicians in patenting and commercializing of their research, which is seen as one way of cooperation. For instance, Bilkent techno-park's Management Company collaborates with 70 academicians, and from these 70 academicians 20 have established their own company inside the techno-park. Most often cooperation with academicians is project based. For example, METU Techno-park's Management Company collaborates with the professors from the Industrial Engineering (IE) and Science and Technology Policy Studies (STPS) departments on OSTIM projects. METU and Bilkent's management companies keep regular contacts with academicians who are holding the training courses and seminars for the tenant firms. Additionally, in METU Techno-park's case, academicians form the jury that evaluate firms which apply to settle inside the techno-park.

Therefore, from these analyses and results it can be concluded that vast majority of both small technology-intensive firms and big companies settled in studied techno-parks comprehend proximity to university as a beneficial factor that aids them in accessing the professional employees. Employing graduates from the near-by university by tenant firms is one type of interaction between the university and companies. According to our logical framework this kind of interaction has positive influence in the sense of formal agreements and transfer of scientific, as well as tacit knowledge.

Moreover, management companies of the studied techno-parks can be seen as a mediator that enhances interactions between the university and tenant firms. From the Interviews with the representatives of the Management Companies we can conclude that in METU and Bilkent techno-parks there are:

- 'new firms formation by the university members' which influence development of formal interactions, transfer of tacit knowledge, and varying degree of personal contacts;
- 'training of firms members', through various seminars and training courses organized by the management companies, have influence on interactions

that typically involve personal contacts and varying degree of transfer of tacit knowledge and formal agreements;

- ‘collaborative research, joint research programmes’, through projects that management companies conduct with academicians and tenant companies, which lead to development of the interactions that typically involve formal agreements, transfer of tacit knowledge and creation of personal contacts ;
- ‘contract research and consulting’, through matching the academicians with the tenant companies that necessitate professional advices, creates interactions that are based on formal agreements, personal contacts and varying degree of transfer of tacit knowledge;
- ‘use of university facilities by firms’, such as library, contributes the development of the interactions through formal agreements; and
- ‘licensing of university patents by firms’ that also creates interactions through formal agreements.

Hence, we can say that there is a certain degree of university-firm interactions in the studied techno-parks. METU and Bilkent techno-parks, through their Management Companies, provide mechanisms that continually encourage universities-firms relationships, whether they are of formal or informal character. Even though close geographical proximity may not be the crucial factor in creating university-firms relationships, it certainly has a facilitating role. According to our logical framework, direct personal interactions by university members and firms’ employees (such as, face-to-face communication facilitated by geographic proximity) generate social capital, such as trust, common language and common culture, which further contributes to eased exchange of knowledge and information. Thus, we believe that due to the geographic proximity, there is common background of both university and tenant firms members which further facilitate creation of social capital through personal interactions.

Even though university-firm interactions in studied techno-parks can be enhanced, it seems that METU and Bilkent techno-parks have established solid base for the further improvements of these interactions. The right policy mechanisms would contribute to the improvement and reinforcement of university-firm relationships in the studied techno-parks.

Testing the Hypothesis 3 and Hypothesis 4

In order to test the hypotheses 3 and 4, we will use results of the questions that belong to part III of our questionnaire (e.g. questions 17 to 26). The theoretical background for the hypotheses 3 and 4 is discussed previously in the logical framework of this thesis.

The Hypothesis 3 is stated as follows:

If the technology-intensive firms are settled in the techno-park then these firms will have higher level of developed inter-firm linkages.

The Hypothesis 4 is stated as follows:

If the technology-intensive firms are settled in the techno-park, and if they have tight inter-firm and firm-university affiliations, they can extract maximum benefits of the techno-park concept and of clustering and networking in general.

Hence, analyses of the questions 17 to 24 will give us basic idea about the inter-firm networks in METU and Bilkent techno-parks, their extent, frequency and type. Results indicate the following:

- From the question 17 we observe whether the tenant firms of the studied techno-parks have developed project-based or short-term interactions among each other. Our results indicate that 53% of the tenant firms in both techno-parks had project-based cooperation with the other firms from the same techno-park (see Table 14). Considering both techno-parks as a whole, 67.6% of tenant firms that have till 10 employees, 24.3% of the firms that have between 11 and 50 employees, and 8.1% of the firms that have more than 50 employees, have joint projects with the other firms (see Appendix D, cross-tabs 4). Only two small technology-intensive firms reported that they had between 10 to 20 common projects (5.4%), while all the others had only 1 to maximum 5 joint projects (56.7% of the firms reported that they had only 1 or 2 common projects).

Table 14. Project-based cooperation among the tenant firms from the same techno-park

Total number of surveyed firms: 70		
	Common projects among the firms settled in the same techno-park (%)	**NO project-based cooperation among the firms settled in the same techno-park (%)**
METU T.P.	53	47
Bilkent C.P.	53	47
TOTAL (METU & Bilkent)	53	47

- From the question 18 we obtained information on the tenant firms long-term cooperation and networks with the other firms from the same techno-park. From Table 15, it can be seen that majority of the firms do not develop networks with other tenant firms in both techno-parks. It is striking that 78% of the firms that do not cooperate with the other firms from the same techno-parks belong to the small tenant firms from the METU and Bilkent techno-parks as a whole (see Appendix D, cross-tabs 5).

Table 15. Long-term cooperation among the tenant firms from the same techno-park

Total number of surveyed firms: 70		
	Cooperation among the firms settled in the same techno-park (%)	**NO cooperation among the firms settled in the same techno-park (%)**
METU T.P.	42	58
Bilkent C.P.	41	59
TOTAL (METU & Bilkent)	41.5	58.5

- From the question 19 we obtain information about particular networks and long-term collaborations developed among METU and Bilkent techno-parks' tenant companies and firms from the other techno-parks. From the table 16 it can be seen that inter-firm networks with the firms from other techno-parks are even less developed than inter-firm networks among the firms from the same techno-park. Besides, considering this issue, there is slight difference between METU and Bilkent techno-parks. From statistical analyses (see Appendix D, cross-tabs

6) it can be seen that 81.3% of the firms that do not cooperate with the firms from the other techno-parks belong to the small firms from METU and Bilkent techno-parks as a whole.

Table 16. Long-term cooperation among the tenant firms from the different techno-parks

Total number of surveyed firms: 70		
	Cooperation with the firms from the other techno-parks (%)	**NO cooperation with the firms from the other techno-parks (%)**
METU T.P.	28	72
Bilkent C.P.	35	65
TOTAL (METU & Bilkent)	31.5	68.5

Moreover, questions 17, 18 and 19, considering METU and Bilkent techno-parks as a whole, show us that:

- 87.9% of the firms that do not have any joint project with other companies from the techno-park also do not develop long-term cooperation with the companies settled in the same techno-park. On the other hand, 32.4% of the firms that do have joint projects do not develop long-term cooperation with the companies from the same techno-park (see Appendix D, cross-tabs 7).
- 87.9% of the firms that do not have any joint project also do not cooperate on the long-term basis with the firms settled in other techno-parks, and 54.4% of the firms that do have joint projects do not develop long-term cooperation with the companies settled in the other techno-parks (see Appendix D, cross-tabs 8).
- From the whole number of the firms in METU and Bilkent techno-parks, 34 of them (48%) have developed inter-firm networks either with the firms from the same techno-park or with the firms settled in other techno-parks or both. Additionally, 58.6% of the firms that reported long-term networks with the firms in the same techno-park also have developed long-term collaboration with the firms settled in other techno-parks. On the other hand, 87.8% of the firms that do not have any long-term cooperation with the firms in the same techno-park also do not have long-term cooperation with the firms settled in other techno-parks (see Appendix D, cross-tabs 9).

From the previous results, we can make the following observations regarding METU and Bilkent techno-parks as a whole:

- Project-based cooperation is not very frequent in the studied techno-parks. Moreover, number of joint projects is not significant. However, majority of the firms that work on common projects belongs to firms that have up to 10 employees. Great majority of the firms that do not have common projects with other firms from the techno-parks also did not develop long-term cooperation and networks with both firms from the same or from other techno-parks.
- Similarly, majority of the firms do not develop long-term cooperation with other companies from the same techno-park. Great majority of the firms that reported they do not collaborate, belongs to the small tenant firms.
- Long-term networks are even less developed among the firms from different techno-parks. Here, great majority of the firms that do not develop this kind of collaboration also belongs to the small tenant firms.
- Furthermore, majority of the firms that develop networks with the other firms from the same techno-park tend to develop networks with the firms from other techno-parks. On the other hand, great majority of the firms that do not have any long-term cooperation with the firms in the same techno-park is not apt to develop long-term cooperation with the firms settled in other techno-parks.

Questions 20 to 24 refer only to the firms who reported any kind of long-term cooperation, whether they collaborate exclusively with the firms from the same techno-park or solely with the firms from other techno-parks or both. Thus, from the whole number of surveyed firms (70) these questions could be answered by 34 firms (16 from METU Techno-park and 18 from Bilkent Cyber-park), From these questions, we obtained the following:

- Question 20[16] exemplifies the type of the cooperation among the firms (see Figure 11, 12 and 13).

[16] Firms had opportunity of multiple choice in this question.

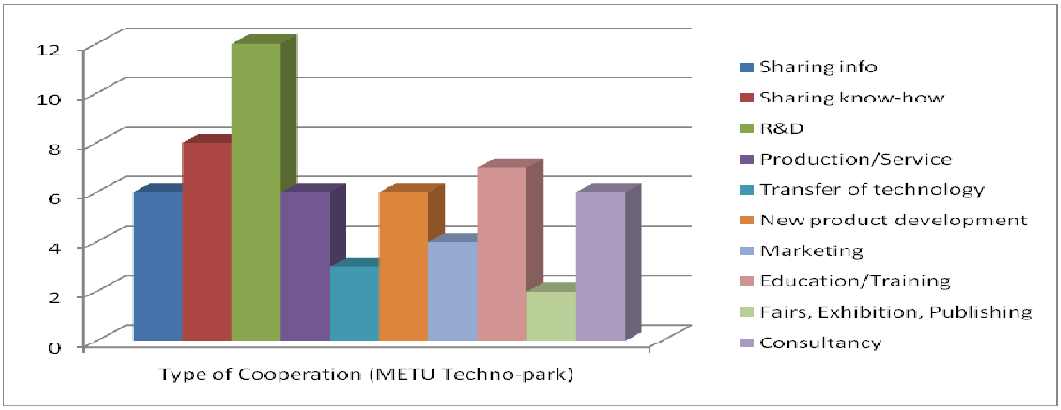

Figure 11. Type of Cooperation reported by METU Techno-park firms

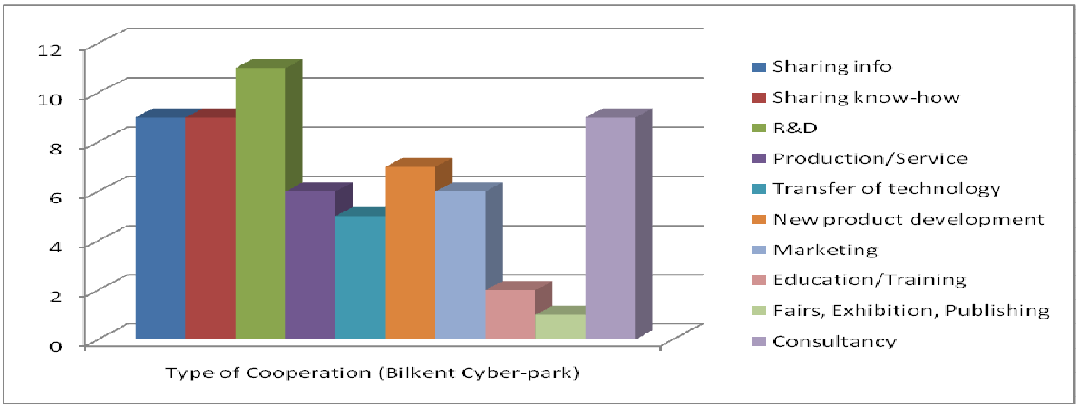

Figure 12. Type of Cooperation reported by Bilkent Cyber-park firms

From Figures 11 and 12, it can be seen that cooperation considering 'R&D' is the most frequent for the firms from both techno-parks. The least conducted type of cooperation among the firms from both techno-parks is 'collaboration on fairs, exhibitions and publishing'. 'Sharing know-how', 'production/service', 'transfer of technology (ToT)', 'new product development (NPD)', and 'marketing' collaborations have almost the same frequency in both techno-parks. Cooperation regarding the 'sharing of information' and 'consultancy' is more frequent in Bilkent Cyber-park than in METU Techno-park, while the greatest dissimilarity between METU and Bilkent techno-parks can be seen in cooperation about 'education and training of the employees'. Figure 13 shows types of cooperation for both METU and Bilkent techno-parks.

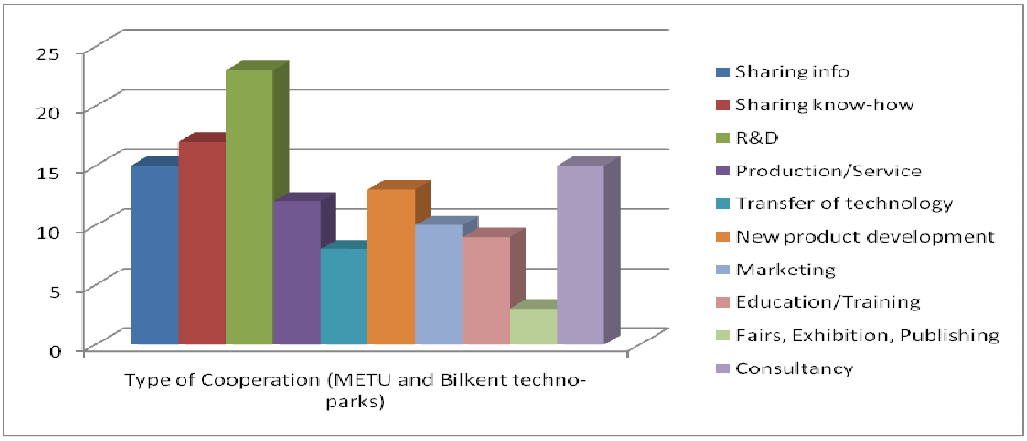

Figure 13. Type of Cooperation reported by METU and Bilkent techno-parks' firms

- In the question 21 we explore the reasons of inter-firms collaboration.

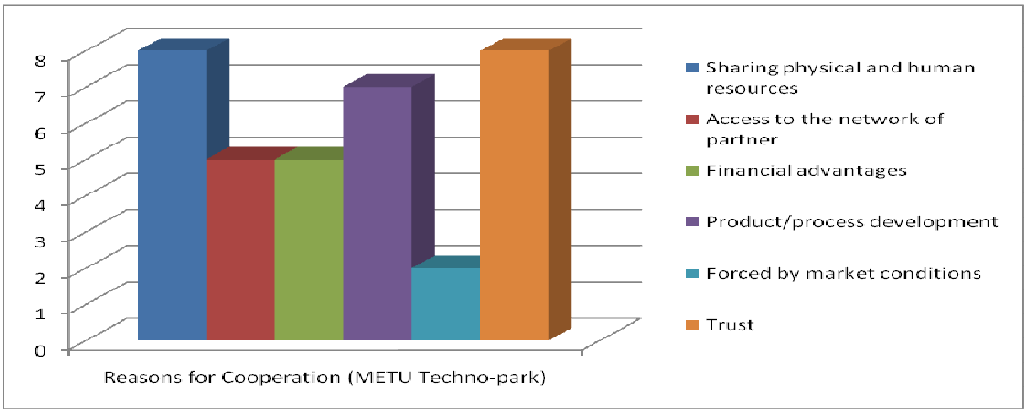

Figure 14. Reasons for Cooperation reported by METU techno-park firms

In both techno-parks 'trust' is the most frequent reason for inter-firm cooperation, while 'market condition forced us' is the least frequent reason (see Figure 14 and 15). Slight differences between METU and Bilkent techno-parks exist regarding this issue. The biggest dissimilarity (even though not significant) between two techno-parks is in the frequency of reporting 'sharing physical and human resources' as a reason for inter-firm cooperation. Figure 16 illustrates 'reasons for cooperation' from the both techno-parks as a whole.

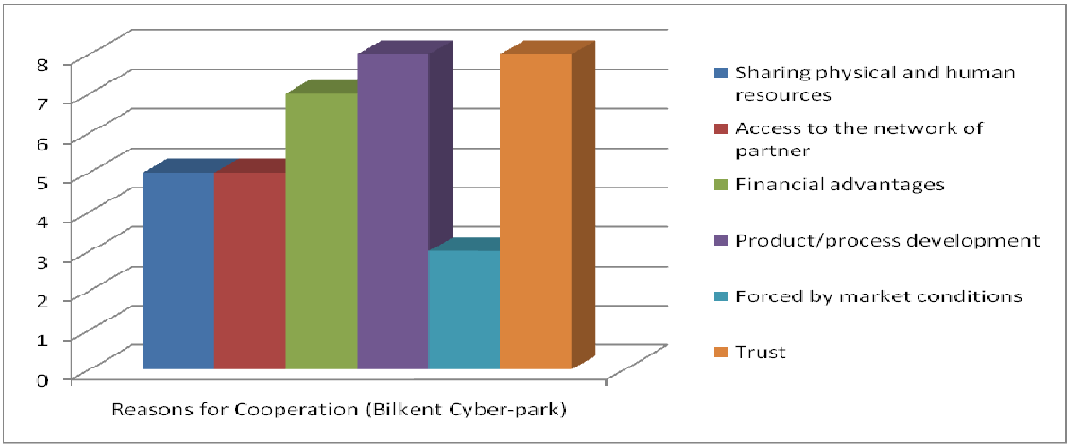

Figure 15. Reasons for Cooperation reported by Bilkent techno-parks firms

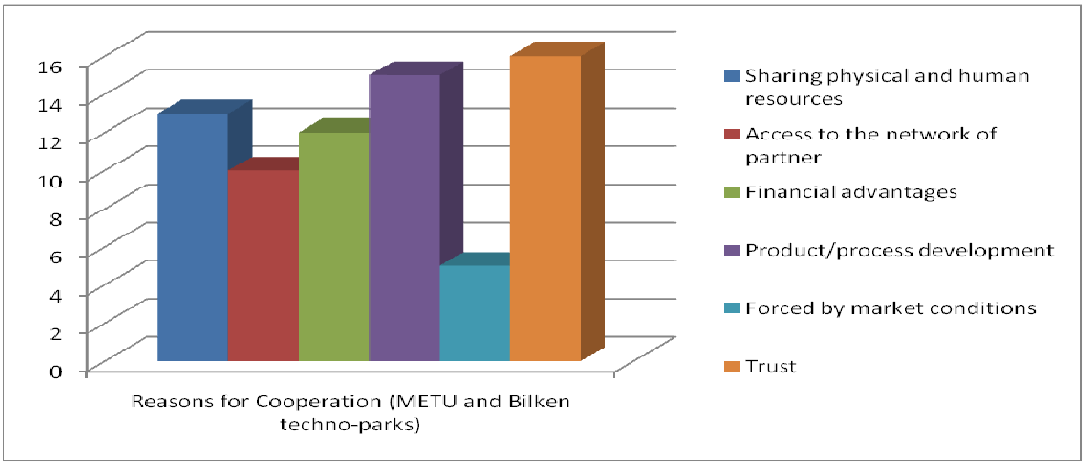

Figure 16. Reason for Cooperation reported by METU and Bilkent techno-parks' firms

- In question 22 we observe if the firms develop inter-firm networks with the companies that are in the same sector. Regarding this issue, there is difference between two techno-parks (see Table 17). In Bilkent Cyber-park great majority of the firms that have developed inter-firm linkages cooperate with the firms in the same sector, while in METU Techno-park percentage of the firms that cooperate in the same sector is almost equal to the percentage of the firms that cooperate with companies from different sectors.

Table 17. Cooperation among the tenant firms from the same/different sector

Applicable for the 34 of surveyed firms		
	Cooperation with the firms from the same sector (%)	**Cooperation with the firms from the different sectors (%)**
METU T.P.	56	44
Bilkent C.P.	89	11
TOTAL (METU & Bilkent)	74	26

- Questions 23 and 24 refer to the frequency and to the importance of inter-firm cooperation. In METU Techno-park 75% of the firms that developed inter-firm networks cooperate often or very often, while in Bilkent Cyber-park that percentage is slightly lower - 61% of the firms cooperate often, very often or permanently (see Table 18). Furthermore, in METU Techno-park all firms that developed inter-firms networks comprehend networking as of middle importance or as very important. Similarly, 94% of the companies from Bilkent Cyber-park comprehend established inter-firm networks as of middle importance or very and vitally important (see Table 19).

Table 18. Frequency of the cooperation among the tenant firms

Applicable for the 34 of surveyed firms					
	Very rarely (%)	**Rarely (%)**	**Often (%)**	**Very often (%)**	**Permanently (%)**
METU T.P.	0	25	62	13	0
Bilkent C.P.	6	33	22	33	6
TOTAL (METU & Bilkent)	3	29	42	23	3

Table 19. Importance of the cooperation for the tenant firms

Applicable for the 34 of surveyed firms					
	Not important (%)	**Little importance (%)**	**Middle importance (%)**	**Very important (%)**	**Vitally important (%)**
METU T.P.	0	0	44	56	0
Bilkent C.P.	0	6	38	50	6
TOTAL (METU & Bilkent)	0	3	41	53	3

Moreover, from the statistical analysis of both techno-parks as a whole (see Appendix D, cross-tabs 9), it can be seen that all companies that comprehend inter-firm networks as "vitally important" cooperate "very often" whereas all the firms that see networking as of "little importance" cooperate "rarely". On the other hand, 71.4% of the firms that cooperate "often" and 75% of the firms that cooperate "very often" comprehend networking as "very important".

From the results of the questions 20 to 24, we can make the following conclusions:

- Majority of the firms in both techno-parks collaborate for the R&D. The lowest importance, in both techno-parks, is given to the collaboration on the fairs, exhibitions, and publishing. Considering both techno-parks as a whole, sharing know-how, information and consultancy are more frequent types of cooperation than collaborations in production/service, NPD, ToT, marketing and education/training of the employees.
- 'Trust' is the most important parameter for developing inter-firm networks in both techno-parks. Collaboration for achieving 'product/process development' is also highly important reason for inter-firm networks in both techno-parks. On the other hand, the least number of firms choose to cooperate because of the unfavourable market conditions. Considering both techno-parks as a whole it is surprising that 'access to network of the partners' is not one of the main reasons for inter-firm cooperation. Firms in METU Techno-park choose to cooperate in order to share human and physical resources more than to achieve financial advantages, while in Bilkent Cyber-park it is vice versa.

- Firms in METU Techno-park develop inter-firm linkages equally with the firms from same and different sectors, while in Bilkent Cyber-park firms mainly develop inter-firms networks with firms from the same sector. This implies that in METU Techno-park complementarity between firms in R&D projects is high.
- Majority of the firms (68%) in both techno-parks cooperate often, very often or permanently. Similarly, majority of the firms (56%) comprehend networking as very important or vitally important. Almost half of the firms (41%) see networking as of middle importance. Great majority of the firms that cooperate often or very often comprehend networking as a very important.

Questions 25 and 26 were designed for the firms that did not establish any kind of long-term cooperation. Thus, these questions were answered by 36 firms in total, 20 of which belong to METU Techno-park and 16 to Bilkent Cyber-park. Throughout these questions we obtained the following results:

- Question 25 shows how firms that do not have developed inter-firm networks comprehend networking. From the whole number of the firms that do not cooperate, 55% in METU Techno-park and 56% in Bilkent Cyber-park intend to establish inter-firm networks. On the other hand, high percentage of the firms in both techno parks is not in favour of networking (see Table 20).

Table 20. How important tenant firms that did not establish inter-firm networks perceive cooperation

Applicable for the 36 of surveyed firms			
	Not beneficial (%)	**Beneficial, but we are not in favour of it (%)**	**Very beneficial, we are working on establishing cooperation (%)**
METU T.P.	0	45	55
Bilkent C.P.	13	31	56
TOTAL (METU & Bilkent)	6.5	38	55.5

- Question 26 refers to the reasons of not cooperating. From the Table 21 it can be seen that in METU Techno-park 10% of the firms reported that policy of their company does not allow establishment of cooperation while 20% of the firms

tried to establish inter-firm networks but did not receive positive feedback from the other companies. Great majority (70%) of the METU Techno-park tenant firms reported other reasons, such as: cooperation could not be established due to the fact that firm was newly established (5%); cooperation is risky (10%); cooperation is not possible because firm's field of business is unique (15%); and firm is in the process of establishing cooperation (40%). In the Bilkent Cyber-park situation is slightly different: 37% of the firms stated that policy of their company does not allow establishment of cooperation, 13% do not know how to establish cooperation, and 19% of the companies tried to establish inter-firm networks but did not receive positive feedback. In comparing with METU Techno-park, small percentage (31%) of the firms reported different reasons, such as: it is risky to cooperate (6%); cooperation could not be established due to the fact that firm was newly established (6%); and cooperation is not possible because firm's field of business is unique (19).

Table 21. Importance of the cooperation for the tenant firms

Applicable for the 36 of surveyed firms					
	Policy (%)	**Do not know how to establish cooperation (%)**	**No positive feedback (%)**	**Unwillingness of other firms to share info, know-how, etc. (%)**	**Other (%)**
METU T.P.	10	0	20	0	70
Bilkent C.P.	37	13	19	0	31
TOTAL (METU & Bilkent)	23.5	6.5	19.5	0	50.5

According to results of the questions 25 and 26 we can conclude that:

- In METU Techno-park, 35% of the firms will not cooperate because of the firm's policy, because cooperation is risky, or because there is no firm in the same field. This percentage is much higher in Bilkent Cyber-park where 62% of the firms will not cooperate for the same reasons.

Additionally, the following conclusion can be made from the Interviews with the representatives of the management companies from METU and Bilkent techno-parks:

- Even though METU Techno-park's management company do not trace level of inter-firms networks, it comprehends METU Techno-park as a cluster whose inter-firm networks need to be fostered and strengthened. It is also believed that tenant firms do not know how to establish cooperation and what are the benefits of inter-firm linkages. Thus, METU Techno-park's management company sees necessity of marketing the idea of clustering and networking as well as rising awareness among the tenant firms about inter-firm networks' benefits.
- Bilkent Cyber-park's management company is aware of the fact that tenant firms have not established efficient inter-firm networks. Moreover, many firms tend to cooperate with the firms from other techno-parks in order to preserve their knowledge, information and ideas from the near-by companies. This is due to the fact that patents in IT sector are hard to be obtained and, thus, firms fear of being exploited by similar tenant companies. Besides, firms have not yet developed culture and knowledge of cooperation. This is due to the fact that techno-parks are relatively new forms of organization in Turkish society and firms are still not able to comprehend the benefits of the cooperation and techno-park environment. Hence, Bilkent Cyber-park's management company, likewise the METU techno-park, sees need of conducting the initiatives directed towards the encouragement of cooperation among the tenant firms.

According to our results, we conclude that in the case of METU and Bilkent techno-parks firms, even though in close geographic proximity to each other, do not cooperate intensively. This is opposite to our postulated hypotheses. Considering the profile of the firms and fact that they are located in the most developed techno-parks in Turkey, it was expected that there will be higher level of inter-firm networking. Moreover, we argue that developed inter-firm networks can be characterized as weak. This is due to the fact that in developed inter-firm networks exchange of information and know-how among the firms has low priority, whereas collaboration in the production/service, ToT, NPD, marketing and education of employees are even less established types of inter-firm networks. Additionally, according to our logical framework, trust is an important facilitating factor for establishing formal and informal networks. In METU and Bilkent techno-parks almost half of the firms that have inter-firm networks reported trust as a reason for networking. This implies that even though trust is most commonly reported reason for networking, half of the firms that cooperate were not able to develop trust

relationships. Similarly, access to partner's networks and sharing human, physical and financial resources is not comprehended as an important reason for networking among the firms. In addition to this, we can add previous findings about mobility of the highly qualified workers. Low levels of 'mobility of workers' and 'spin-offs from existing companies' also indicate weak networking among the tenant firms.

Hence, we perceive that there is a necessity of enhancing developed inter-firms networks in the studied techno-parks if the tenant firms are to extract maximum benefits of the clustering and networking and if studied techno-parks are to be more successful. Consequently, there is high necessity of policy recommendations directed towards the fostering and encouraging networking among the firms that do not cooperate in the studied techno-parks. In line with our theoretical framework, we believe that tenant firms can become more innovative and competitive if they will pursue network form of organization. At the same time, by forming robust inter-firm networks inside the techno-parks, firms can contribute to the advancement of techno-parks into high-tech clusters. Furthermore, METU and Bilkent techno-parks as a high-tech cluster can enhance the success and performance, not only of the tenant firms and hosting techno-parks, but of the region as whole.

4.3. CONCLUDING REMARKS

Certain concluding remarks were extracted from the particular analyses and results of the field survey, and will be discussed in this section.

The cross-tabulation analysis (see Appendix D, cross-tabs 1), indicate that from the whole number of tenant firms that has more than 50 employees in both studied techno-parks, 100% is founded before the year 2001. Also interesting finding, from the same cross-tabulation, is that 91.2% of all tenant firms founded after 2005 in both techno-parks employee up to 10 employees. According to these results, we can assume that small and medium technology-intensive firms will continue in the future to dominate METU and Bilkent techno-parks. Accordingly, strong inter-firm networks will become even more important for these firms if they aim to achieve certain level of innovativeness and economic success.

From the Interviews conducted with the representatives of the techno-parks' management companies, it can be concluded that management companies conduct initiatives directed towards intensification of inter-firm cooperation. METU Techno-park's management company perceives clustering as a strong brand image. It also sees fostering cooperation among the tenant firms and encouraging entrepreneurship as their daily job. METU techno-park, through Management Company, organizes various seminars, training courses and meetings where people can meet and discuss particular issues, as well as social gatherings (e.g. parties). Bilkent Cyber-park's management company goes even further in their vision to create robust high-tech cluster not only among the tenant companies, but among the near-by techno-parks as well. They plan to apply to particular EU funds that would enable them to launch initiatives in this direction. Likewise the METU techno-park's management company, they provide free trainings, seminars and free consultancies, and they organize various projects and study groups where employees of the tenant companies can meet and exchange their knowledge and information. Hence, we assume that METU and Bilkent techno-parks offer potential to the tenant firms to establish robust and intensive inter-firm cooperation, yet there is necessity for policy interventions that would alter this potential into reality.

Even though tenant firms in METU and Bilkent techno-parks perceive proximity to university as highly beneficial in order to access professional employees, they still have problems in finding highly-qualified personnel. Especially this is the case with small technology-intensive tenant firms. We assume that small tenant firms do not want to invest in the highly-qualified labour or do not want to offer attractive wages, due to the fear of losing employee and, thus, losing their investments. Hence, we assume that this could be enhanced in the cooperative environment of the small technology-intensive tenant companies. Otherwise, circulation of the scientific knowledge and development of the local pool of knowledge inside the studied techno-parks will be low.

METU and Bilkent techno-parks' tenant companies have potential of forming cluster with dense inter-firm networks, yet, our previous results indicate that there are no dense inter-firm networks in the studied techno-parks. According to formal and informal information gathered through the field survey, we assume that majority of the firms is not aware of the benefits that they can obtain through inter-firm

networks. Additionally, we assume that firms who set up their policies against networking comprehend sharing information and know-how as a high-risk activity. On the other hand, small technology-intensive firms in the studied techno-parks that tend to cooperate are not able to access the other tenant companies easily. Very small percentage of the cooperation among the tenant firms in the activities such as, marketing, fairs, exhibitions, and education or trainings of the employees implies low possibility of the tenant firms to establish informal networks and friendships with the other companies. We can also assume the low level of informal networks due to the rare mobility of the employees among the tenant firms. Consequently, while conducting the survey, in informal conversations with the interviewees we could often hear the following opinion:

> ''...other companies in the techno-park are so closed for the firms in their environment....for example, we even do not know what kind of job our next-door neighbour is doing...''

Hence, we assume that firms in the studied techno-parks do not comprehend that dense networking, open labour markets and learning from each other can bring more competitive advantage than independency and secrecy. We believe that rising awareness about benefits of collaboration practices and informal exchange can alter the current situation in the studied techno-parks.

In addition, it is important to mention that one of the key features of success of techno-parks, discussed briefly in our logical framework, is availability of the capital ready to take risk of investing in innovation (Castells and Hall, 1994:237), R&D and new technologies. In order to conduct R&D and to be innovative new and small technology-innovative enterprises must find ways of generating funds to keep them alive (Castells and Hall, 1994:232). This capital can further enable technology-intensive firms to prosper and sustain their competitive advantage. According to our analysis (see Appendix E), majority of the firms in METU and Bilkent techno-parks (73%) has EU or TUBITAK-funded projects, or both. Moreover, as discussed previously, there are other institutions that provide R&D funds for techno-park tenant companies which indicate that techno-parks in Turkey offer small technology-intensive tenant companies opportunity to access on the easier way domestic and foreign capital needed to pursue R&D and innovation. Thus, we assume that these funds can aid small technology-intensive firms by providing finance for their development. If used efficiently, these funds can enable firms to become more self-

sustaining over the time and to create more high-risk capital that can be utilized for future R&D and innovation. We also assume that high-risk capital, and local pool of labour and knowledge concentrated inside the techno-parks, will in turn encourage networking, entrepreneurship and experimentation. As in the case of Silicon Valley, this mixture of social networks among the engineers, managers and entrepreneurs can generate creative synergy and desire to cooperate for technological innovation which further may lead to techno-park's vitality, resilience and technological excellence.

CHAPTER 5

CONCLUSION

In this section we want to bridge the logical framework of this thesis with conducted field study. Logical framework enabled us to set up particular characteristics of the theoretical conception regarding techno-parks as a specific form of clustering. Field study provides the general information on the studied techno-parks (particularly METU and Bilkent) and allows us to draw comparison between theory and practice. In the line with the techno-park's features that have been examined in the field study, we will propose in this section the certain policy needs, policy goals and policy instruments. By doing so, we intend to contribute to the overcoming of the weaknesses in the studied techno-parks and to promote their potential using the theoretical concepts of techno-parks and clusters. Section will be completed with short concluding remarks and suggestions for the future research.

5.1. POLICY RECOMMENDATIONS

The previous analysis of METU and Bilkent techno-parks will be used in this section for identifying policy needs and creating policy recommendations in the harmony with logical framework set up on the beginning of the thesis.

According to our previous analyses, we concluded that METU and Bilkent techno-parks' objectives and structure correspond to the basic concept of techno-parks given in the logical framework. Both techno-parks are deliberately planned areas with the main objectives to support: university-industry relationships; formation of the technology-intensive enterprises; birth of spin-offs; creation of networks among the tenant firms; generation of new jobs for highly qualified labour pool; and growth of R&D activities. Along with these objectives, both techno-parks directed their efforts towards the promotion of innovation, and generation of scientific synergy and economic productivity. Both techno-parks are placed in the university's campus

and are mainly comprised of small and medium technology-intensive enterprises. Close geographical proximity to the two best universities in Turkey is perceived as a great advantage for the creation and sustainability of university-industry collaboration. Management companies of these techno-parks provide variety of services that aid development of technology-intensive tenant enterprises.

Moreover, previous results indicate that METU and Bilkent techno-parks have potential of becoming more successful techno-parks and they have potential of forming robust high-tech cluster. Yet there is a necessity for policy interventions that would alter this potential into reality. According to the logical framework, we are able to address and identify missing elements of the studied techno-parks. In fact, METU and Bilkent techno-parks' missing elements construct areas that necessitate policy interventions.

Policy needs

It is of high importance to precisely define here lacking elements of potential successful techno-parks and potential robust high-tech cluster. According to our survey results we identified the following areas that necessitate policy interventions in both METU and Bilkent techno-parks:

- Need to increase level of highly-qualified labour;
- Need to enhance firm-university cooperation;
- Need to encourage development of inter-firm networks inside the techno-park; and
- Need to encourage and enhance development of inter-firm networks among the near-by techno-parks' tenant companies.

By addressing these issues, overall objective of altering potential of techno-parks into practice can be accomplished. Moreover, being part of successful techno-park as a specific form of cluster will enable tenant firms to utilize advantages of the techno-park concept and cluster concept in general.

Policy goals

In logical framework we discussed benefits that tenant firms can obtain in the techno-parks as a specific form of clustering, and benefits of the general clustering concept. Thus, overall policy goal is to enable tenant firms to utilize these benefits by being a constituent part of a successful techno-park or robust high-tech cluster. In order to achieve overall objective, specific goals must be defined and accomplished.

Hence, according to identified policy needs, we can postulate the following specific policy goals:

- *Reinforcement of the highly qualified labour pool*;
- *Strengthening the firm-university networks*;
- *Rising awareness of the benefits of dense networks; encouraging learning from each other; and fostering formal as well as informal exchange of information and know-how*; and
- *Promotion of cooperation among METU and Bilkent techno-parks' tenant companies for the sake of forming robust high-tech cluster*.

Policy instruments

Policy instruments are the specific strategies for achieving policy goals. Thus, after defining policy needs and specific policy goals, we propose the following policy instruments according to the results of the field survey and our assumptions:

1) Qualified labour pool is a necessary factor for the technology-intensive companies, and for techno-park as a whole, to be successful. In order to increase the level of highly-qualified personnel in METU and Bilkent techno-parks we propose:
   a) Organizing various events (e.g. seminars) by management companies with the main theme being the 'importance of the pool of highly-qualified labour for technology-intensive companies settled in the techno-parks'. This type of seminars should be jointly organized with the professionals from the near-by university and should be consisted of theoretical conceptions as well as

illustrative examples from the successful techno-parks and clusters. On this way, tenant firms' awareness of the importance of highly-qualified labour could be enhanced.

b) Organizing study that would investigate specific and detailed reasons of why tenant firms encounter problems when searching for professional employees. Management companies should encourage tenant firms to participate in the study and results should be published. Professional team of the experts should be employed to create solutions for the specific problems identified. By doing so, tenant firms would be able, for instance, to access ideas for possible solutions or learn from the others' experiences. Prerequisite for this to happen is necessity of tenant firms to change their strategy towards the surveys and to become more open towards the field studies. Especially in METU Techno-park, we encountered number of firms that did not want to participate in our survey.

c) Tenant companies should offer part-time jobs to the MS and PhD students from the near-by university. On this way they would get opportunity to market themselves to particular students or their colleagues. This would create possibility for tenant firms to attract qualified labour to stay in the company after finishing their post-graduate studies.

d) Tenant companies should engage in co-supervising MS and PhD thesis. Tenant companies should choose to co-supervise thesis that are related to their field of interests. Moreover, tenant companies should invite MS and PhD students who write their thesis to use tenant firms as an object of the field study. On this way, tenant companies would be able to form formal and informal relationships with the highly-qualified labour.

e) Management companies in collaboration with the near-by university should work on establishing platform where members of tenant companies and MS or PhD students would have opportunity to introduce and meet each other, exchange knowledge and experience and discuss particular problems. For instance, occasional visits of firm members to the university departments as guest lecturers. This would also contribute to the formation of informal relationships between highly-qualified labour and tenant firms, which in turn can ease access to qualified personnel by tenant firms. Additionally, techno-park in collaboration with near-by university can create and publish daily newspapers and weekly magazines where firms can market themselves,

and announce advertisements and profile of needed personnel, and where MS and PhD students can publish their research results or written articles.

f) Moreover, tenant firms should increase their participation in the joint educational and training programmes that can increase the level of skilled labour. Especially in Bilkent Cyber-park, a small percentage of the firms reported this type of collaboration. Through joint educational and training programmes, tenant firms, particularly small technology-intensive firms, can share costs and risks of investment in employees.

g) Lastly, ‘’Project-Based Employment’’ of industry and/or business-experienced advisors holding MS or PhD degree would positively influence interaction among highly qualified personnel and firms in METU and Bilkent techno-parks.

2) Firm-university relationships are comprehended as one of the crucial success factors for the technology-intensive companies, and for techno-park as a whole. Fostering and strengthening these networks must be accomplished by joint efforts of both particular university and particular techno-park. In order to increase level of firm-university interactions in METU and Bilkent techno-parks we propose:

   a) Tenant firms should increase ‘employment of near-by university’s graduates’. They should practice employment of graduate students from near-by university more than through ‘other’ sources (e.g. kariyer.net, friends and family recommendations). For instance, techno-park and university should jointly create an Internet portal where students of near-by university would be able to announce their Curriculums.

   b) Tenant firms and university from the METU and Bilkent techno-parks should jointly participate on various conferences or other similar events. For instance, tenant firms can motivate their highly-qualified employees (e.g. MS and PhD employees) to publish articles at the International conferences, or tenant firms can jointly with university organize International conferences with the themes attractive to the tenant companies and related to their field of functioning (e.g. new trends in IT sector, management of IT companies, innovation and knowledge, regional innovation systems, knowledge spillovers, clusters, networks, etc).

c) Management companies should continue to encourage and motivate 'new firm formation' by university members. For Instance, techno-parks through Management Company can set up certain standards and future vision that would, for example, embrace number of new firms founded by university members per year.
d) Tenant firms' and university's members should participate in joint publications. For example, tenant firms can offer sponsorship to university members for publishing their work if it is related to the tenant company's field or area of functioning.
e) Management companies together with universities should organize informal gatherings and social events, such as, parties, cocktails, exhibitions, and so forth, more often. They should motivate university members to join these informal meetings as they present very efficient way of exchange of information, knowledge and ideas through informal communication.
f) Management companies of METU and Bilkent techno-parks organize various trainings and seminars for tenant firm members. However, they should increase participation of university members in lecturing through these types of trainings and seminars. For instance, young members of university can be motivated to give lectures on trainings organized by management companies because it can enhance their experience and widen their practical skills. On the other hand, management companies should find effective ways to motivate and increase number of tenant firms that participate on these educational events. For example, management companies should organize research about the common interests and needs of tenant firms and afterwards use these findings for creating themes of educational trainings and seminars.
g) Similarly, firm members (e.g. managers of the tenant firms or other high-qualified personnel) should held lectures at university. For instance, under-graduate and graduate faculties which programmes are closely related to the areas of tenant firms functioning should practice inviting firm members to occasionally teach in the classes. At least one lecture of certain courses per semester can be dedicated to the visit of selected tenant firm member. On this way, students can get ideas about the practice and how knowledge gained at university is implemented in the practical work.

h) Mobility of researchers between university and firms should be fostered. Engagement of researchers by tenant companies should be enhanced and fostered. For instance, tenant companies can offer universities' researchers project-based cooperation and joint research programmes (likewise management companies), or contract research and consulting. This implies that researchers would be mobile between their constant jobs at university and projects and/or contracts within tenant companies. Due to the close geographic proximity of university and tenant firms in both METU and Bilkent techno-parks, this mobility is feasible.

i) Management companies should motivate tenant firms and their members to use other facilities, except library, provided by the near-by university. For example, tenant firms which work requires use of laboratory should establish certain arrangements through management companies with the particular faculties in order to utilize their laboratories.

j) Licensing of university patents and purchase of prototypes developed at university by tenant firms should be fostered and enhanced. Management companies, as a mediator between university and tenant companies, should develop more robust relationships with the university members who desire to patent and commercialize their research. Having in-depth information about these members and about prototypes developed at the university will enable management companies to ensure dissemination of this information among tenant companies in need for specific patents or prototypes. On the other hand, this entails information gathering by management companies' regarding their tenant firms' necessities and requirements for particular patents and prototypes.

k) Lastly, management companies should motivate tenant firms to increase the number of joint projects with near-by universities. For instance, tenant companies can utilize project-based employment of university members in a more extensive manner.

3) Intensive and dense inter-firm networks can be characterized as the most crucial success factor emphasized by techno-park and cluster concepts. Networking is comprehended in the literature as the major feature that contributes to the competitiveness and innovativeness of the small technology-intensive companies, and of the techno-park as a whole. Accordingly, many

authors stressed that promotion of networking and implementation of the policies that foster cooperation are the most critical and difficult tasks. Results of our field study depict small percentage of the surveyed tenant firms from both METU and Bilkent techno-parks who have developed inter-firm interactions inside the techno-park. Yet, developed networks are not robust in the sense of sharing knowledge, information and technology. At the same time, our results indicate high potential of tenant firms to form dense inter-firm networks. Hence, there is necessity of fostering networking as well as enhancing developed inter-firm networks in the studied techno-parks if the tenant firms are to extract maximum benefits of the clustering and networking and if studied techno-parks are to be more successful. This also implies strengthening the initiatives of management companies considering this issue. Fostering and strengthening these networks must be accomplished by joint efforts of both particular management company and particular tenant firms. In order to increase elaboration of inter-firm interactions in METU and Bilkent techno-parks we propose:

a) As a starting point, management companies should work on fostering collective identities and trust as mechanisms that support the formation and elaboration of local networks (Saxenian, 1994:167) among the small technology-intensive firms settled in METU and Bilkent techno-parks. This step could also be called as 'raising awareness of each other'. By providing public forums and organizing meetings for exchange and debate, and by motivating tenant companies to participate in such forums, management companies can encourage development of shared understandings and promote intensive cooperation among tenant companies. Specific topics of these meetings and/or forums should be directed towards: 'introducing particular companies to each other' (i.e. companies' branch, areas of functioning, structure, activities, etc), and introducing 'companies field of interests and future visions'. This could further lead to the development of 'community's interests' that would be comprised of common interest of the tenant firms. Besides, these forums would enable firms to learn about each other and to become aware of the potential partners and firms with common interests. Participation in forums can lead to the formation of the informal relationships and friendships among the tenant firms' members. Close geographical proximity eases possibility of frequent meetings and face-to-

face communication which, in turn, fosters development of trust between the parties. This is particularly important for the tenant companies that are: 'new'; 'not in favour of networking'; that pursue 'policies against networking'; that comprehend 'networking as a risky activity'; and 'firms that could not receive positive feedback from the others'.

b) As a second step, an initiative towards 'raising awareness' of the tenant firms about concepts of clustering and techno-parks in general, and networking and cooperation in particular, must be undertaken. Management companies should implement this initiative through organizing various meetings, trainings, seminars and study groups about mentioned topics. Moreover, this step must be carefully prepared and planned. In order to do so, management companies should conduct surveys, or use the ones already conducted like ours, in order to gain clear picture of current situation in techno-parks regarding types and density of inter-firm networks. According to this type of information, more specific topics of the meetings (i.e. trainings or seminars) can be set up. For example, in 'rising awareness' phase, the following themes should be prepared and presented: 'Importance of networking for small technology-intensive companies', 'Importance of learning quickly and adapting to changing environment', 'Benefits of the dense networks inside the techno-parks and in other forms of clusters in general', 'Advantages that individual tenant firms can obtain through networking', 'Specific types of cooperation and their benefits', 'Presentation of achievements of the successful cases, such as Silicon Valley', 'Innovation as collective, not individual, process', and so forth. On this way, tenant companies may become aware of the benefits that they would lose if choosing to stay independent and isolated from techno-park environment. This awareness may further motivate tenant companies reporting that 'networking is not beneficial', 'policy of the company do not allow cooperation', and 'networking is risky' to alter their attitudes and policies. The same can be true for the tenant companies who reported that they comprehend networks as of 'little' or 'middle' importance. According to our results, tenant firms who comprehend networking as highly beneficial have developed inter-firm networks, and oppositely, firms that cooperate rarely comprehend networking as of 'little' importance. Thus, we believe that rising awareness of inter-firm networking may lead to creation of more intensive

and dense networks among tenant companies. Moreover, throughout participation on these trainings and seminars, tenant companies members are given opportunity to meet potential partners and develop informal relationships and trust. This is particularly important for the young tenant companies who have problems in finding partners. Additionally, through these events companies that 'made efforts to develop networks but could not receive positive feedback' can reach and meet alternative partners willing to cooperate. Participation in trainings and seminars can strengthen formation of informal relationships, friendships, and trust among the tenant firms' members.

c) Initiatives of 'How to establish cooperation' should be undertaken among the tenant firms that have not developed inter-firm networks and relationships. This initiative should also be implemented through trainings and seminars by management companies. Professionals from the near-by university can be engaged in lecturing. Moreover, study groups composed of different representatives from few companies can be organized. Each study group should be engaged in creating concrete solutions for particular tasks considering establishing networks among tenant companies. Time frame for creating solutions and occasional meetings within each study group should be set up. This would present platform where tenant companies can discuss 'real-life' problems, exchange their ideas and knowledge about how to establish effective cooperation. Through discussions and joint case studies they can learn from each other, and develop and initiate implementation of possible solutions. Lecture outline and created solutions can be published and distributed to all tenant companies.

d) Among the tenant companies with developed inter-firm networks, initiatives towards intensification of 'exchange of know-how and information', 'cooperation in ToT', 'collaboration in marketing', 'cooperation in education and training of employees', and 'cooperation in exhibitions, fairs and publishing' should be undertaken. Moreover, importance of 'access to partners' network' and of 'sharing resources' should be promoted. Management companies can conduct initiatives in this direction through seminars that would promote importance of trust, openness among the partners and exchange of know-how. However, we believe that trust among the partners need considerable time and repeated interactions in order to be

fully developed. Trust and repeated interactions are mutually dependent – higher level of trust will lead to repeated interactions, and repeated interactions will further strengthen trust among the partners. Once developed and strengthened, trust will facilitate and trigger exchange of know-how, sharing information regarding technology and partner's network, and sharing of resources. Participation in trainings and seminars organized by management companies can enhance trust among the tenant companies. This is due to the fact that these events enable occasional meetings and face-to-face interactions among the tenant companies' members. Moreover, in order to facilitate trust and, thus, exchange of know-how and information, management companies can undertake initiatives to support and motivate tenant companies to participate in joint actions such as 'collaboration in marketing', 'collaboration in education and training' and 'collaboration in exhibitions, fairs and publishing'. This is important because these less formal collaborations can open up the ways for more formal and more complex cooperation.

e) Our results depict that tenant firms who work jointly on the project-basis are more likely to develop long-term networks. Management companies should, thus, foster tenant companies to engage in project-based cooperation. Throughout the joint projects firms can develop knowledge about each other and trust towards partners in the project. This project-based cooperation can gradually lead to a long-term cooperation and elaboration of inter-firm networks.

f) Moreover, in order to strengthen cross-company learning networks and interactive communication, management companies can initiate formation of professional associations according to types of the sector and sub-sectors in techno-parks, or more specific common interests of tenant companies' members. For example, Association of software engineers, Association for women in high-tech sector, Association for entrepreneurs, and so forth. In the case of Silicon Valley these types of associations combined monthly meetings with online communications and led to development of learning communities, strong social networks and helped innovation to diffuse rapidly through the region (Benner, 2003). Inspiration for creating such associations can be found, for instance, in Silicon Valley case and Benner's illustration (2003) of 'Silicon Valley Webgrrls' association. The logic behind this is that

these associations provide opportunity to people with common jobs or interests to: connect to each other; to exchange experiences; to share various information related to new market trends and new technologies; and even to share new jobs and business leads. All of these can influence more frequent and intense mobility of skilled workers among the tenant companies. Occasional meetings among members of particular association can be supported by on-line forums and on-line communication. Through participation in these associations, members of tenant companies can: develop sense of greater openness; increase personal networks of information and knowledge exchange; develop informal relationships; reach to certain information unavailable through formal channels and, thus, stay on the top of sectoral trends and changing skill demands. In one word, members of certain associations can become resource for each other in maintaining knowledge on specific skills that are in demand (Benner, 2003). According to Benner (2003), professional associations and other occupationally-based groups may prove highly productive, as in case of Silicon Valley.

4) Dense networking among various actors in the techno-park is perceived as a key factor in techno-park's competitiveness. Yet, techno-parks must generate and preserve certain extent of external linkages in order to preserve and increase their success in local and international level. In the case of METU and Bilkent techno-parks, relationships and interactions between two techno-parks would not only contribute to advancement of each techno-park but could also lead to the elaboration of robust high-tech cluster. We comprehend that there is potential for formation of such cluster due to: geographic proximity of two techno-parks; presence of two best universities in Turkey; and good location, infrastructure and image. According to our results, there is low level of inter-firm networks developed among two techno-parks. However, in order to develop 'Silicon Valley' of Ankara (as even stated in the vision of Bilkent Cyber-park') efforts of both METU and Bilkent techno-parks should be directed towards the encouragement of more intense and more dense inter-firm networks among two techno-parks. In order to achieve this, we propose the following:
   a) METU and Bilkent techno-parks' management companies should firstly set up tight cooperation and develop joint actions in order to promote inter-firm

networks among tenant companies from two techno-parks. Both techno-parks have similar objectives, structure and visions and, thus, development of cooperation among two management companies should go smoothly. Joint actions by both management companies should encompass: defining common objectives for development of inter-firm networks between two techno-parks, and cooperative creation of action plans in order to achieve those objectives. Shared funds for realisation of those objectives should be jointly provided by two techno-parks as well. Moreover, joint efforts of both management companies for establishing external cooperation, for example with another techno-parks in Turkey (e.g. with Hacettepe Techno-park that is also in close proximity to METU and Bilkent techno-parks) or with particular International techno-parks and high-tech clusters, would be more productive and efficient.

b) The instruments for fostering and strengthening inter-firm networks within each techno-park, discussed previously, can be implemented for the encouragement and support of inter-firm networks between two techno-parks as well. Cooperation among companies from two different techno-parks can open up more possibilities for tenant companies. On this way, companies that could not develop inter-firm networks because 'there is no similar company in their techno-park' could have opportunity to learn about companies that are alike but settled in other techno-parks. Thus, they would be given possibility to connect and establish cooperation.

c) Lastly, management companies of both techno-parks should jointly encourage development of joint projects among two techno-parks. Initially project-based cooperation may further lead to the elaboration of the long-term networking among the two techno-parks as well as among the tenant companies from two techno-parks.

5.2. CONCLUDING REMARKS

The main purpose of this thesis is to investigate if there are dense and intensive inter-firms networks among METU and Bilkent techno-parks companies. In order to do so, first we generated the logical framework composed of short theoretical discussions regarding the concepts of innovation and knowledge, clusters and

networks concepts, and techno-park concept. Logical framework of the thesis has further been used as a guide throughout the field survey analyses and design of policy recommendations.

Results of the field survey have been used in order to test validity of the hypotheses postulated on the beginning of the thesis. The main findings according to the analyses of survey's results can be summarized as:

- There is low level of high-qualified personnel (i.e. personnel who hold Ms or PhD degree) in the tenant companies of METU and Bilkent techno-parks; and there is extremely low level of the mobility of workers among the tenant companies. Hence, level of highly-qualified employees should be increased through policy interventions proposed in this thesis. Besides, mobility of workers can be enhanced if the firms would develop more intense inter-firm networks and if there would be more frequent inter-firm collaboration based on sharing human resources.
- Firm-university linkages are evident in both techno-parks. However, they should be strengthened and enhanced by implementing policy interventions proposed in this thesis.
- There is low level of inter-firm networks in both METU and Bilkent techno-parks: majority of tenant firms did not develop inter-firm networks whereas elaborated inter-firm networks are rather weak. Thus, formation of inter-firm networks and enhancement of existing networks should be fostered and supported throughout the implementation of policy interventions proposed in this thesis.

Results of our survey also indicated that:

- Structure and organization of METU and Bilkent techno-parks correspond to the key characteristics of the theoretical conceptualization of successful techno-park establishments. However, there are particular missing elements (regarding level of high qualified personnel, university-firm linkages, and inter-firm networks) that need to be addressed and improved by policy interventions described below, if METU and Bilkent techno-parks are to be more successful and competitive techno-parks in the sense of the theory.
- There is a potential for elaboration of dense and intensive firm-university and inter-firm networks and relationships.

Hence, according to the logical framework, we argued that:

- If development of inter-firm interactions inside the techno-parks would be fostered, and if intensification of existing inter-firm networks would be promoted, tenant firms would be able to utilize advantages of clustering concept in the sense of the theory.
- If inter-firm networks among tenant companies from two techno-parks would be encouraged and enhanced, cooperation among METU and Bilkent techno-parks would be strengthen, and formation of high-tech cluster would be possible.

Results of the survey have afterwards been used for generation of policy recommendations. This process entailed: identification of policy needs; definition of policy goals according to identified policy needs; and suggestions for policy instruments in order to achieve defined objectives. Needs, objectives and policy instruments were designed according to the lacking or weak features of METU and Bilkent techno-parks compared to the successful techno-park model.

The following policy needs have been identified:

- *Need to increase level of highly qualified labour;*
- *Need to enhance firm-university cooperation;*
- *Need to encourage development of inter-firm networks inside the techno-park; and*
- *Need to encourage and enhance development of inter-firm networks among the near-by techno-parks' tenant companies.*

Hence, the following specific policy goals have been postulated:

- *Reinforcement of the highly qualified labour pool*;
- *Strengthening the firm-university networks*;
- *Rising awareness of the benefits of dense networks; encouraging learning from each other; and fostering formal as well as informal exchange of information and know-how*; and
- *Promotion of cooperation among METU and Bilkent techno-parks' tenant companies for the sake of forming robust high-tech cluster*.

Consequently, the following policy instruments have been proposed:

1) In order to increase level of highly-qualified personnel in METU and Bilkent techno-parks, it has been proposed:
   - *Organizing various events pointing out importance of the high-qualified labour for technology-intensive companies settled in the techno-parks' (by management companies);*
   - *Organizing study in order to discover why tenant firms have problems in finding professional employees (by management companies);*
   - *Offering part-time jobs to the MS and PhD students from the near-by university by tenant companies;*
   - *Supervision of MS and PhD thesis by tenant companies;*
   - *Creating platform for exchange of knowledge and information among tenant companies' members and MS and PhD students;*
   - *Increasing cooperation among tenant companies and their participation in the joint educational and training programmes;*
   - *Project-Based Employment of industry/business experienced advisors (holding MS or PhD degree).*

2) In order to increase level of firm-university interactions in METU and Bilkent techno-parks, it has been proposed:
   - *Increase 'employment of near-by university's graduates' by tenant companies;*
   - *Joint participation of tenant companies' and universities' members on various conferences and other similar events;*
   - *Encourage of 'new firm formation' by university members;*
   - *Joint publications by tenant firms and university;*
   - *Organizing informal gatherings and social events by management companies and universities;*
   - *Increasing number of university members who held trainings and seminars organized by management companies for tenant firms;*
   - *Lecturing at university by tenant firm members;*
   - *Mobility of researchers between university and tenant firms;*
   - *Increase utilization of university facilities by tenant companies;*

- *Licensing of university patents and purchase of prototypes developed at university by tenant firms;*
- *Increasing the number of joint projects between tenant firms and universities.*

3) In order to increase elaboration of inter-firm interactions in METU and Bilkent techno-parks, it has been proposed that management companies should:
   - *Develop activities for 'raising awareness of each other' among tenant firms through various forums and meetings organized by management companies;*
   - *Develop activities for 'raising awareness' of the tenant firms about benefits of the concepts of clustering and techno-parks in general, and networking and cooperation in particular;*
   - *Undertake activities for increasing knowledge and information about 'How to establish cooperation' for tenant firms that have not developed inter-firm networks and relationships;*
   - *Undertake initiatives towards intensification of 'exchange of know-how and information', 'cooperation in ToT', 'collaboration in marketing', 'cooperation in education and training of employees', and 'cooperation in exhibitions, fairs and publishing' for tenant companies with developed inter-firm networks;*
   - *Foster engagement of tenant firms in project-based cooperation;*
   - *Initiate formation of professional associations according to types of the sector and sub-sectors in techno-parks, or according to more specific common interests of tenant companies' members;*

4) In order to encourage development of more intense and more dense inter-firm networks among METU and Bilkent techno-parks' firms, it has been proposed:
   - *Development of joint cooperation among METU and Bilkent techno-parks' management companies in order to generate joint actions for promotion of inter-firm networks among two techno-parks;*
   - *The same instruments proposed for fostering and strengthening inter-firm networks within each techno-park, can be implemented for the encouragement and support of inter-firm networks between two techno-parks;*
   - *Increasing the number of joint projects between METU and Bilkent techno-parks.*

According to conclusions of this thesis, if the identified missing elements of METU and Bilkent techno-parks would be carefully addressed and promoted by proposed policy instruments, small technology-intensive tenant firms would be able not just to survive but to achieve higher level of innovativeness and growth, and to improve their competitive performance as argued in the theoretical framework of this thesis.

5.3. SUGGESTIONS FOR FUTHER RESEARCH

Our study presents general approach for evaluation of METU and Bilkent techno-parks' characteristics. Results of the field study have been designed in order to form general perception of existence and intensity of inter-firm and firm-university networks in the studied techno-parks. Hence, we recognize necessity of the future research in the same field in order to improve effectiveness and accuracy of our research and results. We propose the following:

1) In our study we have been investigated if tenant companies have problems in finding professional employees. High percentage of the surveyed firms has reported this problem. We, thus, perceive importance of additional analysis to further explore concrete reasons and difficulties that firms encounter when searching for professional workers. Results of such analyses would provide more in-depth information that would further enable development of more effective policy recommendations for enhancing the level of highly-qualified personnel in the tenant companies.
2) Through our survey and interviews we have obtained more general information about the firm-university linkages inside METU and Bilkent techno-parks. Our results indicate existence of these networks and necessity for their intensification. Yet, we identify the need for more detailed analysis of particular types and intensity of developed firm-university interactions. Besides investigating more closely how firms cooperate with near-by university, future research should also encompass analyses regarding: frequency of firms cooperation with near-by university; how firms perceive importance of firm-university cooperation; and what are concrete benefits that firms gain from firm-university interactions. Results of such analyses would provide more detailed information that would further enable creation of

more effective policy instruments for enhancing the level of firm-university cooperation.

3) Moreover, we perceive importance of future work that would have main objective of analyzing tenant companies' level of innovativeness in relation to the developed inter-firm networks. Additionally, comparing innovativeness among METU and Bilkent techno-parks' tenant companies that have developed and that have not elaborated inter-firm networks is one more important subject of the future research. This research should incorporate more quantitative data and quantitative methods for analyzing collected data. Results of such analyses would provide more detailed information that would further shape direction of policy instruments regarding inter-firm cooperation inside the techno-parks.
4) From the theoretical point of view, mobility of workers and spin-offs from existing companies are important indicator of intensity and density of informal networking and personal relationships among the companies, as well as more effective exchange of information and tacit knowledge. Our analyses depict low level of mobility and spin-offs in METU and Bilkent techno-parks. Thus, we propose future research among the tenant firms' employees that would investigate the reasons of why they do not prefer to change the jobs and switch from one to another company inside the techno-park. Results of such analyses would provide more in-depth information about the low mobility of skilled workers inside the techno-parks. Accordingly, these results would shape direction of policy recommendations and would contribute to more effective policy instruments for enhancing the level of informal inter-firm cooperation and exchange of tacit knowledge among the techno-parks tenant companies.

Moreover, one closely related future research suggestion is the evaluation and follow-up of the results from the operational phase if our policy recommendations will be put into the practice.

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APPENDIX A

Some of the Main Cluster and Techno-park Definitions

SOME OF THE MAIN CLUSTER DEFINITIONS

(Source: partially based on Belussi (2005), and Bergman and Feser (2002))

Rosenfeld, 1997: 'A cluster is very simply used to represent concentration of firms that are able to produce synergy because of their geographic proximity and interdependence, even though their scale of employment may not be pronounced or prominent.'

Feser, 1998: 'Economic clusters are not just related and supporting industries and institutions, but rather related and supporting institutions that are more competitive by virtue of their relationships.'

Roelandt and den Hertog, 1999: 'Clusters can be characterized as networks of producers of strongly interdependent firms (including specialized suppliers), linked to each other in a value-adding production chain. In some cases clusters also encompass strategic alliances with universities, research institutes, knowledge intensive business services, bridging institutions (brokers, consultants) and customers.'

Enright, 1996: 'A regional cluster is an industrial cluster in which member firms are in close proximity to each other.'

Asheim and Isaksen, 2002: 'The crux of the regionalization argument is that the regional level, and specific local and regional resources may still be important in firms' effort to obtain global competitiveness...firms in the cluster rely on unique regional resources and local cooperation when innovating.'

SOME OF THE MOST COMMONLY USED DEFINITIONS OF TECHNO-PARKS:

UKSPA, 1985: 'A science park is a property-based initiative which: has formal operational links with a university or other higher education or research institution; is designed to encourage the formation and growth of knowledge-based businesses and other organizations normally resident on site; has a management function which is actively engaged in the transfer of technology and business skills to the organizations on site.'

AURRP, 1997: 'The definition of a research or science park differs almost as widely as the individual parks themselves. However, the research and science park concept generally includes three components:

- A real estate development
- An organizational program of activities for technology transfer
- A partnership between academic institutions, government and the private sector.'

Ferguson R. and Olofsson C., 2004: 'Science parks are property-based ventures, with links to universities and/or other academic research institutions that aim to support technology-based businesses and the transfer or development of new technology through the provision of a high quality, full service business location.'

EC Report, 2007: 'A science/technology/research park is a business park where the primary activity of the majority of establishments is research and/or new product or process development-distinct from manufacturing, sales, headquarters, or other similar business functions.'

PWC, 2002: 'A Technology Park or technopolis is a zone of economic activity composed of universities, research centres, industrial and tertiary units, which realise their activities based on research and technological development. Technology Parks are limited in geographic area but maintain network links to large firms and public research infrastructure at both national and international levels.'

APPENDIX B

Field Survey - Enterprise Questionnaire

PART I: GENERAL INFORMATION ABOUT THE SURVEYED FIRM

1) Name of the firm: _____

2) Sector:

1. IT
2. Electronics
3. Other: _____

3) Year of establishment:

1. Before year 2001
2. Between the 2001 and 2005
3. After the 2005

4) Please explain organizational structure of your firm:

1. Family – Limited Firm (Ltd.)
2. Local partner excluding Family (As. Corporation – A.Ş.)
3. Foreign partner or Liaison office of foreign company
4. Other: _____

5a) Please explain the size of your mother (main) firm:

1. Till 50 employees
2. Between 51 and 250 employees
3. Above the 250 employees
4. There is no mother firm

5) Please explain the size of your techno-park firm:

1. Till 10 employees
2. Between 11 and 50 employees
3. Above the 50 employees

PART II: INFORMATION ABOUT THE EMPLOYEES

6) Please explain the level of education of the personnel that work in your firm?

1. Phd. (how many) : _____

2. MS. or MBA : _____
3. BS : _____
4. High School : _____
5. Other : _____

7) What is the distribution of personnel that work in your firm?

1. Management : _____
2. R & D : _____
3. Production – Implementation - Test : _____
4. Other (Sales-Purchase-Account-Sec) : _____

8) Do you have problems in finding the professional employees?

1. Yes
2. No

9) How do you find your professional employees?

1. From other firms in the techno-park
2. From firms settled in other techno-park
3. From other firms outside the techno-parks
4. Abroad
5. Technical education schools/programmes (e.g. University)
6. Other: _____

10) Do you find it beneficial to be near the University in order to access professional employees?

1. Yes
2. No

11) Did you have an experience of loosing the employee who left your company and went to another company located in **the same** techno-park?

1. Yes: _____ (Please indicate the approximate number of those employees)
2. No

12) Did you have an experience of loosing the employee who left your company and went to another company located in **the other** techno-park?

1. Yes: _____ (Please indicate the approximate number of those employees)
2. No

13) Did you have an experience of the employee who left your company and established his own company in **the same** techno-park?

1. Yes: _____ (Please indicate the approximate number of those employees)
2. No

14) Did you have an experience of the employee who left your company and established his own company in **the other** techno-park?

1. Yes: _____ (Please indicate the approximate number of those employees)
2. No

PART III: INFORMATION ABOUT THE COOPERATION BETWEEN THE FIRMS

15) Does your company have and/or had an EU project / EU financed project?

1. Yes: _____ (Please indicate the approximate number of those projects)
2. No

16) Does your company have and/or had TUBITAK project / TUBITAK financed project?

1. Yes: _____ (Please indicate the approximate number of those projects)
2. No

17) Is there any project that your company is working and/or had worked on with other companies within the techno-park?

1. Yes: _____ (Please indicate the approximate number of those projects)
2. No

18) Have your firm cooperated with the other firm/firms from **the same** techno-park?

1. Yes
2. No

19) Have your firm cooperated with the other firm/firms from **the other** techno-park?

1. Yes
2. No **[If both** 18th and 19th questions are answered as **"NO", PLEASE GO TO THE QUESTION no. 25]**

20) If 18th and/or 19th is answered as "YES", please explain the type of cooperation [feel free to mark as many types as applicable for your case]:

1. Sharing information
2. Sharing know-how
3. Research and Development (R&D) and/or design
4. Production/Service
5. Transfer of technology
6. New product development
7. Marketing
8. Education – Trainings
9. Cooperation in the fairs, exhibition, publishing
10. Consultancy
11. Other:

_____

21) If YES (18th and/or 19th) please explain the reasons of the cooperation:

1. Sharing physical and human resources
2. Having access to the network of the partner
3. Financial advantages (lowering the costs and/or rising the profits)
4. Product/process development
5. Market conditions (new markets, high-tech environment, high risks) force us
6. Trust between firms
7. Other:

_____

22) If YES (18th and/or 19th question) please explain do you cooperate with the firms in the same techno-park from the same sector?

1. Yes
2. No

23) If YES (18th and/or 19th question), please explain how frequent do you cooperate with the other firms from the techno-parks?

1. Very rarely
2. Rarely
3. Often
4. Very often
5. Permanently

24) If YES (18th and/or 19th question), please explain how beneficial cooperation with the other firms from the techno-parks is?

1. Not important
2. Little importance
3. Middle importance
4. Very important
5. Vitally important

25) If 18th and 19th questions are answered as NO, please explain do you think that cooperating with the other firms from the same techno-park can be beneficial?

1. No
2. Yes, but we are not in favour of it
3. Yes, it can be very important; we are working on establishing such cooperation

26) If you do not cooperate with the firms from the same and/or other techno-park, but if you think that cooperation would bring benefits to your (and the partner's) firm, please state the reasons why do you not cooperate:

1. Policy of our company do not allow us to establish cooperation with the other firms in the same and/or other techno-park
2. We do not know how to establish the cooperation
3. We tried, but we could not receive positive feedback
4. We tried, but the other firms did not want to share their information, know-how, etc.
5. Other:

_____

APPENDIX B (continued)

Field Survey - Interviews Questions

1. What is the role of the management company (Metutech/Cyberpark)?
2. Do the firms have free access to the University and its resources (employees, laboratories, library, etc)? And in what extent?
3. If yes, do you have information if the firms use those resources?
4. Are there criteria for selecting the firms that will operate in the techno-park?
5. After the firms start to operate, do you keep in touch with them?
6. Do you have any agreement for cooperation signed with the companies within your techno-park? If yes, how many?
7. Do you work on any EU project with the companies settled in the techno-park? If yes, how many?
8. Do you work on any TUBITAK project with the companies settled in the techno-park? If yes, how many?
9. How many academicians are cooperating with you?
10. How many companies from your techno-park cooperate with the companies from another - METU/BIlkent techno-park?
11. Do you know for any network/joint venture inside the techno-park?
12. From your point of view, do firms have potential to form the strong cluster in this techno-park?
13. If yes, what do you think why they do not tend to cooperate?
14. Does the management of the techno-park use any kind of initiatives to foster cooperation among the firms settled in the techno-park?
15. From your point of view, would it be beneficial if the firms would cooperate among themselves – beneficial both for the firms and for technological development?

APPENDIX C

Organizational Structure

Detailed organizational structure of the surveyed firm in the METU and Bilkent techno-parks:

Table C1. Organizational structure of the surveyed firms

Total number of surveyed firms: 70				
	Ltd. (%)	**AŞ. (%)**	**Foreign Partner (%)**	**Other (%)**
METU T.P.	70	25	5	/
Bilkent C.P.	65	26	3	6
TOTAL (METU & Bilkent)	67	26	4	3

Table C2. The size of the firms' mother firm

Total number of surveyed firms: 70				
	<50 employees (%)	**Between 51-250 (%)**	**Above 250 (%)**	**No mother Firm (%)**
METU T.P.	22	8	3	67
Bilkent C.P.	26	15	3	56
TOTAL (METU & Bilkent)	24	12	3	61

APPENDIX D
SPSS Analysis: Cross-Tabulations

Table D1. Cross-Tabulation 1 (METU and Bilkent techno-park as a whole; Questions 3 and 5)

year * TP_firm_size Crosstabulation

Count

		TP_firm_size			
		till 10 employees	11 to 50 employees	above 50 employees	Total
year	before 2001	8	5	4	17
	2001 to 2005	13	6	0	19
	after 2005	31	3	0	34
Total		52	14	4	70

year * TP_firm_size Crosstabulation

			TP_firm_size			
			till 10 employees	11 to 50 employees	above 50 employees	Total
year	before 2001	Count	8	5	4	17
		% within year	47.1%	29.4%	23.5%	100.0%
		% within TP_firm_size	15.4%	35.7%	100.0%	24.3%
	2001 to 2005	Count	13	6	0	19
		% within year	68.4%	31.6%	.0%	100.0%
		% within TP_firm_size	25.0%	42.9%	.0%	27.1%
	after 2005	Count	31	3	0	34
		% within year	91.2%	8.8%	.0%	100.0%
		% within TP_firm_size	59.6%	21.4%	.0%	48.6%
Total		Count	52	14	4	70
		% within year	74.3%	20.0%	5.7%	100.0%
		% within TP_firm_size	100.0%	100.0%	100.0%	100.0%

Table D2. Cross-Tabulation 2 (METU and Bilkent techno-park as a whole; Questions 5 and 8)

TP_firm_size * problem_in_finding_employees Crosstabulation

Count

		problem_in_finding_employees		
		yes	no	Total
TP_firm_size	till 10 employees	31	21	52
	11 to 50 employees	5	9	14
	above 50 employees	1	3	4
Total		37	33	70

TP_firm_size * problem_in_finding_employees Crosstabulation

			problem_in_finding_employees		
			yes	no	Total
TP_firm_size	till 10 employees	Count	31	21	52
		% within TP_firm_size	59.6%	40.4%	100.0%
		% within problem_in_finding_employees	83.8%	63.6%	74.3%
	11 to 50 employees	Count	5	9	14
		% within TP_firm_size	35.7%	64.3%	100.0%
		% within problem_in_finding_employees	13.5%	27.3%	20.0%
	above 50 employees	Count	1	3	4
		% within TP_firm_size	25.0%	75.0%	100.0%
		% within problem_in_finding_employees	2.7%	9.1%	5.7%
Total		Count	37	33	70
		% within TP_firm_size	52.9%	47.1%	100.0%
		% within problem_in_finding_employees	100.0%	100.0%	100.0%

Table D3. Cross-Tabulation 3 (METU and Bilkent techno-park as a whole; Questions 5 and 10)

TP_firm_size * beneficial_to_be_near_uni Crosstabulation

Count

		beneficial_to_be_near_uni		
		yes	no	Total
TP_firm_size	till 10 employees	44	8	52
	11 to 50 employees	12	2	14
	above 50 employees	4	0	4
Total		60	10	70

TP_firm_size * beneficial_to_be_near_uni Crosstabulation

			beneficial_to_be_near_uni		
			yes	no	Total
TP_firm_size	till 10 employees	Count	44	8	52
		% within TP_firm_size	84.6%	15.4%	100.0%
		% within beneficial_to_be_near_uni	73.3%	80.0%	74.3%
	11 to 50 employees	Count	12	2	14
		% within TP_firm_size	85.7%	14.3%	100.0%
		% within beneficial_to_be_near_uni	20.0%	20.0%	20.0%
	above 50 employees	Count	4	0	4
		% within TP_firm_size	100.0%	.0%	100.0%
		% within beneficial_to_be_near_uni	6.7%	.0%	5.7%
Total		Count	60	10	70
		% within TP_firm_size	85.7%	14.3%	100.0%
		% within beneficial_to_be_near_uni	100.0%	100.0%	100.0%

Table D4. Cross-Tabulation 4 (METU and Bilkent techno-park as a whole; Questions 5 and 17)

TP_firm_size * common_projects_same_TP Crosstabulation

Count

		common_projects_same_TP				
		yes (1or2)	no	yes (3-5)	yes (8-20)	Total
TP_firm_size	till 10 employees	14	27	9	2	52
	11 to 50 employees	7	5	2	0	14
	above 50 employees	3	1	0	0	4
Total		24	33	11	2	70

TP_firm_size * common_projects_same_TP Crosstabulation

			common_projects_same_TP				
			yes (1or2)	no	yes (3-5)	yes (8-20)	Total
TP_firm_size	till 10 employees	Count	14	27	9	2	52
		% within TP_firm_size	26.9%	51.9%	17.3%	3.8%	100.0%
		% within common_projects_same_TP	58.3%	81.8%	81.8%	100.0%	74.3%
	11 to 50 employees	Count	7	5	2	0	14
		% within TP_firm_size	50.0%	35.7%	14.3%	.0%	100.0%
		% within common_projects_same_TP	29.2%	15.2%	18.2%	.0%	20.0%
	above 50 employees	Count	3	1	0	0	4
		% within TP_firm_size	75.0%	25.0%	.0%	.0%	100.0%
		% within common_projects_same_TP	12.5%	3.0%	.0%	.0%	5.7%
Total		Count	24	33	11	2	70
		% within TP_firm_size	34.3%	47.1%	15.7%	2.9%	100.0%
		% within common_projects_same_TP	100.0%	100.0%	100.0%	100.0%	100.0%

Table D5. Cross-Tabulation 5 (METU and Bilkent techno-park as a whole; Questions 5 and 18)

TP_firm_size * cooperation_same_TP Crosstabulation

Count

		cooperation_same_TP		
		yes	no	Total
TP_firm_size	till 10 employees	20	32	52
	11 to 50 employees	6	8	14
	above 50 employees	3	1	4
Total		29	41	70

TP_firm_size * cooperation_same_TP Crosstabulation

			cooperation_same_TP		
			yes	no	Total
TP_firm_size	till 10 employees	Count	20	32	52
		% within TP_firm_size	38.5%	61.5%	100.0%
		% within cooperation_same_TP	69.0%	78.0%	74.3%
	11 to 50 employees	Count	6	8	14
		% within TP_firm_size	42.9%	57.1%	100.0%
		% within cooperation_same_TP	20.7%	19.5%	20.0%
	above 50 employees	Count	3	1	4
		% within TP_firm_size	75.0%	25.0%	100.0%
		% within cooperation_same_TP	10.3%	2.4%	5.7%
Total		Count	29	41	70
		% within TP_firm_size	41.4%	58.6%	100.0%
		% within cooperation_same_TP	100.0%	100.0%	100.0%

Table D6. Cross-Tabulation 6 (METU and Bilkent techno-park as a whole; Questions 5 and 19)

TP_firm_size * cooperation_other_TP Crosstabulation

Count

		cooperation_other_TP		
		yes	no	Total
TP_firm_size	till 10 employees	13	39	52
	11 to 50 employees	5	9	14
	above 50 employees	4	0	4
Total		22	48	70

TP_firm_size * cooperation_other_TP Crosstabulation

			cooperation_other_TP		
			yes	no	Total
TP_firm_size	till 10 employees	Count	13	39	52
		% within TP_firm_size	25.0%	75.0%	100.0%
		% within cooperation_other_TP	59.1%	81.3%	74.3%
	11 to 50 employees	Count	5	9	14
		% within TP_firm_size	35.7%	64.3%	100.0%
		% within cooperation_other_TP	22.7%	18.8%	20.0%
	above 50 employees	Count	4	0	4
		% within TP_firm_size	100.0%	.0%	100.0%
		% within cooperation_other_TP	18.2%	.0%	5.7%
Total		Count	22	48	70
		% within TP_firm_size	31.4%	68.6%	100.0%
		% within cooperation_other_TP	100.0%	100.0%	100.0%

Table D7. Cross-Tabulation 7 (METU and Bilkent techno-park as a whole; Questions 17 and 18)

common_projects_same_TP * cooperation_same_TP Crosstabulation

Count

		cooperation_same_TP		
		yes	no	Total
common_projects_same_TP	yes (1or2)	14	10	24
	no	4	29	33
	yes (3-5)	9	2	11
	yes (8-20)	2	0	2
Total		29	41	70

common_projects_same_TP * cooperation_same_TP Crosstabulation

			cooperation_same_TP		
			yes	no	Total
common_projects_same_TP	yes (1or2)	Count	14	10	24
		% within common_projects_same_TP	58.3%	41.7%	100.0%
		% within cooperation_same_TP	48.3%	24.4%	34.3%
	no	Count	4	29	33
		% within common_projects_same_TP	12.1%	87.9%	100.0%
		% within cooperation_same_TP	13.8%	70.7%	47.1%
	yes (3-5)	Count	9	2	11
		% within common_projects_same_TP	81.8%	18.2%	100.0%
		% within cooperation_same_TP	31.0%	4.9%	15.7%
	yes (8-20)	Count	2	0	2
		% within common_projects_same_TP	100.0%	.0%	100.0%
		% within cooperation_same_TP	6.9%	.0%	2.9%
Total		Count	29	41	70
		% within common_projects_same_TP	41.4%	58.6%	100.0%
		% within cooperation_same_TP	100.0%	100.0%	100.0%

Table D8. Cross-Tabulation 8 (METU and Bilkent techno-park as a whole; Questions 17 and 19)

common_projects_same_TP * cooperation_other_TP Crosstabulation

Count

		cooperation_other_TP		
		yes	no	Total
common_projects_same_TP	yes (1or2)	9	15	24
	no	4	29	33
	yes (3-5)	8	3	11
	yes (8-20)	1	1	2
Total		22	48	70

common_projects_same_TP * cooperation_other_TP Crosstabulation

			cooperation_other_TP		
			yes	no	Total
common_projects_same_TP	yes (1or2)	Count	9	15	24
		% within common_projects_same_TP	37.5%	62.5%	100.0%
		% within cooperation_other_TP	40.9%	31.3%	34.3%
	no	Count	4	29	33
		% within common_projects_same_TP	12.1%	87.9%	100.0%
		% within cooperation_other_TP	18.2%	60.4%	47.1%
	yes (3-5)	Count	8	3	11
		% within common_projects_same_TP	72.7%	27.3%	100.0%
		% within cooperation_other_TP	36.4%	6.3%	15.7%
	yes (8-20)	Count	1	1	2
		% within common_projects_same_TP	50.0%	50.0%	100.0%
		% within cooperation_other_TP	4.5%	2.1%	2.9%
Total		Count	22	48	70
		% within common_projects_same_TP	31.4%	68.6%	100.0%
		% within cooperation_other_TP	100.0%	100.0%	100.0%

Table D9. Cross-Tabulation 9 (METU and Bilkent techno-park as a whole; Questions 23 and 24)

frequency_of_cooperation * importance_of_cooperation Crosstabulation

Count

		importance_of_cooperation					
		little importance	middle importance	very important	vitally important	NA	Total
frequency_of_cooperation	very rarely	0	1	0	0	0	1
	rarely	1	7	2	0	0	10
	often	0	4	10	0	0	14
	very often	0	1	6	1	0	8
	permanently	0	1	0	0	0	1
	NA	0	0	0	0	36	36
Total		1	14	18	1	36	70

frequency_of_cooperation * importance_of_cooperation Crosstabulation

			importance_of_cooperation					
			little importance	middle importance	ery importan	vitally important	NA	Total
frequency_of_coope	very rarely	Count	0	1	0	0	0	1
		% within frequency_ cooperation	.0%	100.0%	.0%	.0%	.0%	100.0%
		% within importance_ cooperation	.0%	7.1%	.0%	.0%	.0%	1.4%
	rarely	Count	1	7	2	0	0	10
		% within frequency_ cooperation	10.0%	70.0%	20.0%	.0%	.0%	100.0%
		% within importance_ cooperation	100.0%	50.0%	11.1%	.0%	.0%	14.3%
	often	Count	0	4	10	0	0	14
		% within frequency_ cooperation	.0%	28.6%	71.4%	.0%	.0%	100.0%
		% within importance_ cooperation	.0%	28.6%	55.6%	.0%	.0%	20.0%
	very often	Count	0	1	6	1	0	8
		% within frequency_ cooperation	.0%	12.5%	75.0%	12.5%	.0%	100.0%
		% within importance_ cooperation	.0%	7.1%	33.3%	100.0%	.0%	11.4%
	permanent	Count	0	1	0	0	0	1
		% within frequency_ cooperation	.0%	100.0%	.0%	.0%	.0%	100.0%
		% within importance_ cooperation	.0%	7.1%	.0%	.0%	.0%	1.4%
	NA	Count	0	0	0	0	36	36
		% within frequency_ cooperation	.0%	.0%	.0%	.0%	100.0%	100.0%
		% within importance_ cooperation	.0%	.0%	.0%	.0%	100.0%	51.4%
Total		Count	1	14	18	1	36	70
		% within frequency_ cooperation	1.4%	20.0%	25.7%	1.4%	51.4%	100.0%
		% within importance_ cooperation	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table D10. Cross-Tabulation 10 (METU and Bilkent techno-park as a whole; Questions 18 and 19)

cooperation_same_TP * cooperation_other_TP Crosstabulation

Count

		cooperation_other_TP		
		yes	no	Total
cooperation_same_TP	yes	17	12	29
	no	5	36	41
Total		22	48	70

cooperation_same_TP * cooperation_other_TP Crosstabulation

			cooperation_other_TP		
			yes	no	Total
cooperation_same_TP	yes	Count	17	12	29
		% within cooperation_same_TP	58.6%	41.4%	100.0%
		% within cooperation_other_TP	77.3%	25.0%	41.4%
	no	Count	5	36	41
		% within cooperation_same_TP	12.2%	87.8%	100.0%
		% within cooperation_other_TP	22.7%	75.0%	58.6%
Total		Count	22	48	70
		% within cooperation_same_TP	31.4%	68.6%	100.0%
		% within cooperation_other_TP	100.0%	100.0%	100.0%

APPENDIX E

EU and TUBITAK Funded Projects

Results regarding the EU and TUBITAK-funded projects - questions 15 and 16 in the questionnaire:

Table E1. EU and TUBITAK-funded projects

Total number of surveyed firms: 70			
	EU projects (%)	**TUBITAK projects (%)**	**Both EU and TUBITAK (%)**
METU T.P.	20	78	14
Bilkent C.P.	38	53	29
TOTAL (METU & Bilkent)	29	65.5	21.5

From the Table 24 it can be seen that majority of the firms in studied techno-parks has TUBITAK projects. TUBITAK funded projects are more popular among the firms than EU projects. In this matter, there is dissimilarity between METU and Bilkent tehno-parks: while tenant firms in METU Techno-park have greater number of TUBITAK projects, tenant firms in Bilkent Cyber-park have more EU projects and higher percentage of the both funded projects.

From the whole number of surveyed firms in both techno-parks (70), only 27% do not have neither EU nor TUBITAK funded project (37% in Bilkent Cyber-park and 17% in METU Techno-park).