SCIENCE AND TECHNOLOGY POLICIES RESEARCH CENTER
TEKPOL Working Paper Series
STPS-WP-12/04

Establishment and Development of Academic Spin – Off Firms by Evidence from Turkey and Some Policy Recommendations

Yelda ERDEN **Alp Eren YURTSEVEN**

TEKPOL | Science and Technology Policies Research Center
Middle East Technical University
Ankara 06531 Turkey
http://www.stps.metu.edu.tr

Science and Technology Policies Research Center
TEKPOL Working Paper Series

Establishment and Development of Academic Spin – Off Firms Evidence from Turkey[1]

Yelda Erden
yeldae@metu.edu.tr
METU-TEKPOL

Alp Eren Yurtseven
aeyurtseven@gmail.com
METU-TEKPOL

Abstract

This study aims to identify the main characteristics of academic spin – off firms, which evolve from universities through commercialization of intellectual property and transfer of technology developed within academic institutions. Academic spin – off firms can be conceptualized as a subset of new technology-based firms and they emerge as important actors of the innovation system in Turkey. Despite the extensive empirical evidence pointing to the conclusion that most new technology-based firms do not grow and more importantly do not even want to grow, the dominating view of new technology-based firms is presuming rapid growth, or at least an aspiration towards it. In addition to problems associated with the liability of newness, academic spin – off firms also face two fundamentally different difficulties: Academic spin – off firms evolve from non – commercial environments, i.e. universities and research laboratories, and have to overcome substantial obstacles on the way to become a profitable organization. Moreover key stakeholders in the founding process (i.e. the academic entrepreneurs, university management, finance suppliers etc.) may have conflicting interests, which may influence the growth pattern of academic spin – off firms. Solution of these problems call for a redefinition of parent organization's structure and mission statement. Recently emerging "third mission" paradigm puts forward entrepreneurialism as a new pillar in addition to teaching and research. This study attempts to highlight key characteristics of ASOF's and obtained results are expected to contribute to the intellectual debate about transformation of universities with an entrepreneurial mind set. Obtained results indicate that founders of academic spin – off firms have precedent joint research experience, i.e. network of researchers and role of research group as a quasi- firm is influential in the founding process of academic spin – off firms. Moreover academic spin – off firms are embedded in networks, rather than being atomistic entities and either structure of these networks change, or academic spin – off firms partake in different networks during their development.

Keywords: Academic spin – off, new technology-based firm, entrepreneurial university

[1] First version of this paper was presented in "DRUID-DIME Academy Winter Conference 2010 for doctoral students in Innovation, Knowledge and Entrepreneurship" in Aalborg, Denmark

1. Introduction

Entrepreneurship is supported throughout the world mainly due to the common belief that a high rate of new business activity can boost economic growth and decrease unemployment. Governments in different countries have adopted various measures to foster economic growth through creation and support of small-medium enterprises (SME). Despite the common belief that a high rate of entrepreneurial activity shall result in economic growth, not all new enterprises but technology-based ones possess the potential of high growth, quality job creation and survival in the long term.

Increasing importance of entrepreneurship in innovation policies has a bearing on the university system as well. Primary objective of universities has long been training students and preparing them for professional life. After the 2nd World War, basic research has also taken its place among the mandates of universities. Recently emerging "third mission" concept requires transfer and commercialization of research results conducted within universities. This transition requires redefinition of university values and institutions. Universities, which once used to contribute to society by providing high level education, are now expected to form more "direct" links to the economy. Consequently universities are more prone to appropriate intellectual property emanating from their research. Moreover public funding schemes are increasingly directing universities to undertake collaborative research projects with the industry. Academic entrepreneurship is one of the many modes of technology transfer from universities to industry.

Academic spin-off firms can be conceptualized as a subset of new technology-based firms and they emerge as important actors for innovation in Turkey. Despite the extensive empirical evidence pointing to the conclusion that most new technology-based firms do not grow and more importantly do not even want to grow, the dominating view of new technology-based firms is presuming rapid growth, or at least an aspiration towards it. In addition to problems associated with the liability of newness, academic spin-off firms also face two fundamentally different difficulties: 1)Academic spin-off firms evolve from non-commercial environments, i.e. universities and research laboratories, and have to overcome substantial obstacles on the way to becoming a profitable organization. 2)Key stakeholders in the founding process (i.e. the academic entrepreneurs, university management, finance suppliers etc.) may have conflicting interests, which may influence the growth pattern of academic spin-off firms (Vohora et.al.2004).

This study aims to bring an insight to the commercialization process of academic

knowledge specifically through new enterprises established by researchers. Consequently the answers to following questions are sought: What factors drive academic researchers to establish their own enterprise? Do ASOFs rely on their internal sources in their innovation activities or do they actively seek external resources? What is the role of ASOFs in other firms' innovative activities? In this semi – quantitative study, our unit of analysis is the academic spin – off firm. Rest of this text is structured as follows. Following section presents the conceptual framework of this study and evidence from existing literature is elaborated to espouse the proposed arguments. Details of sample of firms surveyed for this study and questionnaire results are presented in Section 3. Obtained results are analyzed in Section4. Section 5 presents an attempt to map the founding process of a typical ASOF. Section 6 concludes the text with policy recommendations pertaining to the role of academic – spin off firms in Turkey's national innovation system and directions for further research.

2. Conceptual Framework and Theoretical Bases:

2.1. New Technology-based Firms

New technology-based firms can be broadly identified as those that introduce innovations to the market, expected to have none or few competitors and use cutting edge technology (Storey and Tether, 1998). The term "New Technology-based Firm" (NTBF) shall be used to designate such enterprises throughout the rest of this text. "Newness" can be attributed to both the firm itself and the technology developed or applied within the firm. According to Storey and Tether, a central reason for the interest by policy makers in NTBFs is their apparent capacity—based on the US experience—to create, directly and indirectly, employment and wealth. In their work, Storey and Tether (1998) cite a Bank Boston study held in 1997 reporting that 4000 MIT related companies had employed 1.1 million people and had annual sales of $232 billion.

In their study Utterback and Abernathy (1975) partially describe the nature of innovation in small firms. Using the data available from Myers' and Marquis' study of successful innovations, they argue that the character and atmosphere of small firms is one which is particularly suited to encouraging *major product innovations*. By taking one step further, Bollinger et. al. (1983) state that in addition to being prolific innovators, NTBFs extend the boundaries and constraints of technological know – how. In his study, Roberts (1989) focuses on the strategic differences of the "super successes" among a cluster of 21 Boston-area firms that had already survived for at least five years and had already attained at least $5 million in annual sales. These studies mainly focus on the founding process of

NTBFs, the motivational characteristics of "high technology entrepreneurs", and on the financing of NTBFs, and treat NTBFs as atomistic entities, focusing on the growth dynamics while neglecting the technological environment in which such firms operate.

Autio (1994) suggests that although NTBFs have been the target of great expectations and hopes, many of these expectations came to be unrealistic. NTBFs have not turned out to be the automatic generators of economic wealth and new employment in the way that many policymakers expected. According to Autio (1994), NTBFs are essentially concentrations of technology and instead of overemphasizing those few examples of high-growth firms, the nature of NTBFs should be taken into account. In his later work Autio states despite the extensive empirical evidences pointing to the conclusion that most NTBFs do not grow and more importantly do not even want to grow, the dominating view of new technology-based firms is presuming rapid growth, or at least an aspiration towards it (Autio, 1998).

2.2. Academic Spin – Off Firms[2]

The three major forms of mechanisms through which academic institutions and academicians transfer knowledge are *(i)* the diffusion of research knowledge through conferences and scientific publications, *(ii)* the training of a skilled labor force and *(iii)* the commercialization of knowledge. The commercialization of knowledge can itself be considered under many alternative mechanisms, notably through consulting activities, research contracts with industry (sponsored research), patenting and spin-off formation (Goldfarb and Henrekson, 2003). Spin-off formation is the most vivid mode of commercialization of knowledge created within the parent organizations (Landry et.al, 2006).

Academic spin – off firms (ASOF) can be conceptualized as a subset of NTBFs. They are companies which evolve from universities through commercialization of intellectual property and transfer of technology developed within academic institutions (Djokovic and Soutaris, 2008). Due to the fact that commercialization of university ideas generally requires the continuing involvement of academic inventors (Goldfarb and Henrekson, 2003), ASOFs can be accepted as the most effective way of commercialization of

[2] A taxonomy of the literature on university entrepreneurship can be found in Rothaermel et. al.(2007)'s extensive work . After reviewing 173 articles published in a variety of academic journals, they report the emergence of four major research streams; i) entrepreneurial research university, ii) productivity of technology transfer offices, iii) new firm creation, and iv) environmental context including networks of innovation (Rothaermel et. al., 2007). Mustar et. al.(2006) highlight the heterogeneity of the research on academic spin – off firms. Present study mainly focuses on the new firm creation and the environmental context.

knowledge in universities. Pirnay et. al. (2003) defines ASOFs as new firms created to exploit commercially some knowledge, technology or research results developed within a university. In this case researchers establish a new firm. However starting a new venture usually does not mandate the researchers to leave their academic positions permanently, nor take a leave of absence. They can maintain their positions in universities, while having a significant equity position in the new firm (Goldfarb and Henrekson, 2003).

Emanating from the success stories of the well-known "Silicon Valley" and "Route 128" around prestigious universities such as Stanford and MIT, ASOFs have been a research topic in the U.S.A for a long time (Cooper, 1971; Roberts and Peters, 1981; Roberts, 1989). On the other hand Pirnay et. al.(2003) report the lack of interest on the European side. Our literature review yields no evidence specific to Turkey.

Commercialization of scientific knowledge has been acknowledged as an important issue in a number of policy documents[3]. Law # 5746 also focuses on this issue and provides a number of financial incentives to R&D performing firms. The law envisages seed capital support to entrepreneurs with substantial scientific background. Ministry of Science, Technology and Industry (MoSTI) provides seed capital support to successful entrepreneurs in accordance to this act. Moreover MoSTI runs a program, which aims to integrate industrial R&D projects to graduate level thesis work carried out in universities. Scientific and Technological Research Council of Turkey has a program to facilitate transfer of technology developed in universities to SME's. Although a number of public incentives exist, their efficacy on the creation of new firms and commercialization of scientific knowledge remains to be ascertained.

2.3. Entrepreneurial University

The role of entrepreneurship is seen as an important means to policymaker to gain international competitiveness and to lead higher education sector to shape institutional development and cultural change (Gibb and Hannon, 2006). Universities should be in new partnerships with other stakeholders in society to sustain and strengthen their status, because it is claimed that in the world of global corporations and information technology, universities can no longer be the sole or possibly even the main source of intellectual property (ibid). In this respect the concept of entrepreneurship fits with the traditional university form through description of third mission of the university. The missions of universities, so to say education and research, are complemented by a third, economic and

[3] See Gören (2008) for an analysis of Supreme Council of Science and Technology resolutions in a historical context.

social development mission of serving to society, innovation and technology transfer processes (Mets, 2010). The adoption of third mission for the universities is defined as second academic revolution and this revolution transformed the university into a teaching, research and economic development enterprise (Etzkowitz, 2003:110). Therefore, entrepreneurial university can be accepted as a university structure that emerged as the outcome of second academic revolution (Mets, 2010). Scientific and managerial competences of a university should be harmonized to form an entrepreneurial university and in this context the systematic transfer of knowledge through technology transfer, continuing education and adjustment to labor market replaces the classical missions of research and education (Zaharia and Gilbert, 2005)

The entrepreneurial university is defined as the university which possesses a wide range of new infrastructural support mechanisms for fostering entrepreneurship within the organization as well as packaging entrepreneurship as a product (Jacob et.al, 2003: 1556). Therefore, as Clark (1998) claimed institutional entrepreneurship is seen as both process and outcome and the term "entrepreneurial" for this kind of universities are used deliberately to point out actions that lead to change in organizational structure of the university.

In the analysis of German and US national university system, Lehrer et.al (2009) found that at macro level, the premises of university entrepreneurialism are *(i)* decentralized competition (e.g. open science) *(ii)* latitude in mission and revenue mix (autonomy and liberty in mission and the determination of financial resource portfolio) and *(iii)* a nationwide, diversified bidding system for the funding of large-scale university-based research (a well-funded marketplace for scientific ideas). These are accepted as the contextual factors that prepare appropriate conditions for entrepreneurial universities in national university system and in this context entrepreneurial characteristics emerge at individual university level such as *(1) organizational innovations for achieving economies of scope (e.g. for achieving synergies between basic and applied research, teaching, and cooperation with industry); (2) an institutionalized capacity for strategic selection of research foci; and (3) a capacity to contribute to the development of new industries (Lehrer et.al, 2009:270).*

Being an entrepreneurial university requires organizational and institutional rebuilding that enables university to do business for its own sake and actively seeks to innovate about its own business (Lazzeretti and Tavoletti, 2005). According to Clark (1998:5-8), to transform

a traditional university into an entrepreneurial university, the following elements should be satisfied as irreducible minimum:

(1) *Strengthened steering core:* To become more quicker, more flexible and more focused in reactions to changing and expanding demands, greater managerial capacity and more organized way of management are needed for universities concerned about their marginality and survivability,
(2) *Expanded developmental periphery:* This is needed for an enterprising university to reach out of traditional university borders and to cooperate with the outside organizations and groups. This periphery includes organizational structures such as professionalized outreach offices (such as technology transfer offices) and interdisciplinary project oriented research centers,
(3) D*iversified funding base:* An entrepreneurial university should widen and deepen its financial resource portfolio and has to find alternative financial funds other than mainline income of institutional support from government. This financial diversification enhances university to make quick and significant moves without waiting system-wide enactments that come slowly. This diversification also decreases the risk of losing financial resources in case of reversal of the application for government funds,
(4) *Stimulated academic heartland*: In an entrepreneurial university, the academy should also accept a modified belief system and the research units in university (department and faculties) need to become entrepreneurial units that are reaching more strongly to outside with new programs and relationships, and their members should participate the central steering groups,
(5) *an integrated entrepreneurial culture:* entrepreneurial universities should develop a work culture that is compatible with change and that should become an institutional university-wide culture that follows the development of other first four elements

It must be emphasized that a university cannot be entrepreneurial by just creating entrepreneurial structures; it must change the conception of the university's mission in society (Zaharia and Gilbert, 2005).

3. Arguments about ASOFs derived from Empirical Literature

After investigating 7 spin – off firms from public research institutions from New Mexico, U.S.A and Japan; Carayannis et.al (1998) state that former research experience of founders and the state of technology being developed are decisive on the founding process of such firms. Krabel and Mueller (2009) analyze survey interviews of 2604 scientists

working for the Max Planck Society in Germany and their empirical results indicate that the entrepreneurial activities of scientists heavily depend on patenting activity, entrepreneurial experience, and personal opinions about the benefits of commercializing research and close personal ties to industry. Etzkowitz (2003) suggests that academic research groups are "quasi-firms" led by a principal investigator who manages a team. These individuals perfect their skills at a number of management tasks including proposal writing, recruitment, managing post-docs, writing and reviewing articles, serving on review panels, and so forth. Based on these studies, about founding structures and network features of ASOFs, following arguments are raised:

Argument 1) Researchers with similar affinities form a research group and partake in collaborative research activities.

Argument 2) Founders of the ASOF anticipate the commercial benefits of their research results.

Argument 3) Founders of the ASOF have personal ties (i.e. providing consultancy services, partaking in joint R&D projects etc.) to industry.

Depending on their separate individual studies conducted on Portuguese NTBFs in electronics and information sectors, Laranja and Fontes (1998) state that NTBFs in Portugal perform a wide variety of knowledge-intensive activities, which enhance local users' adoption processes and they are associated with different forms of technology transfer through external linkages. Overall, NTBFs undertake a frequently unobserved role as technology searchers and acquirers that, pushed by *idiosyncratic local niche market opportunities*, selectively choose among and enhance technologies developed elsewhere, introducing them into the local market (Laranja and Fontes, 1998). Conducting their research on 48 Italian ASOFs, Chiesa and Piccaluga (2000) claim that spinning-off from academic institutions are the most promising way to transfer research results to the market place. Kroll and Liefner (2008) provide present results from a comparative study based on data from 82 interviews with ASOFs in three metropolitan regions in China and their study shows that government-driven spin-off formation proved to be an appropriate solution for technology transfer from Chinese universities. After elaborating these studies, about the knowledge production and technology transfer roles of ASOFS, following arguments are proposed:

Argument 4) ASOFs have a knowledge transformation function, i.e. they transform the knowledge created within the parent organization and relay it to the market by means of new products and/or services.

Argument 5) ASOFs function as "knowledge producers", i.e. through their knowledge transformation and development capabilities they provide inputs to other firms' innovations.

Johansson et. al.(2005) investigate the relationship between universities and academic spin – off firms, with special emphasis on the antecedent conditions and the nature of the linkages that these firms form, as well as the means for sustaining them. Using the instrumental case study approach on 4 Swedish academic spin-off firms, their results indicate that the network relations of these firms were characterized by a small number of strong ties to universities, with a high degree of trust and informality. In their study Audretsch et. al.(2005) indicate that academic spin-off firms have a high propensity to locate close to universities, presumably in order to access knowledge spillovers. Based on the findings of these studies, in the establishment phase about the location choice of ASOFs, following point is deduced:

Argument 6) ASOFs remain geographical proximity to their parent organizations in order to benefit from knowledge spillovers, easy access to research infrastructure and qualified employees.

4. Descriptive Summary of the Data

Preliminarily, 30 ASOFs were identified. Publicly available lists of firms benefiting from government support programs, internet sources and authors' own acquaintances with the founders of ASOFs were used for this purpose. Identified firms are independent from each other and they are selected from different sectors. A questionnaire consisting of 16 sections covering many aspects of foundation and development phases of ASOFs, in addition to the variety of their innovative activities, was prepared and e – mailed to these firms. Valid responses from 12 firms (return rate 40%) were received. Rather low response rate did not comprise a serious problem since this study is conducted in a semi – quantitative fashion. List of surveyed sample of firms accompanied by their short descriptions is presented in Table 1. In order to protect the privacy of the case study firms, their names have been disguised.

Table 1: List of sample firms

Firm Name	*Short Description*	*Year Founded*	*Employees*
Alpha Nano - Ceramics	Development of piezoelectric crystals	2008	6
Bravo Aeronautics	Design and manufacture of airplane components and wind tribunes	2006	6
Charlie Audiotech	Audio processing software development	2000	27
Delta Radars	Design and manufacture of radar systems	2001	7
Echo Simulation	Simulation software development	2006	44
Foxtrot Nano - Materials	Development of coating methods with nano materials	2006	10
Golf Genetics	Development of diagnosis methods based on molecular genetics	2007	3
Hotel Biotechnology	Development of plant preservatives	2004	6
India Magnetic Equipments	Design and manufacture of measurement and precision equipment	1999	8
Juliet Vision Technologies	Development of machine vision technologies for production lines	2006	8
Kilo Advanced Materials	Development and manufacture of ceramic cutting heads	2004	9
Lima Biochem	Development of diagnosis kits and pharmaceutical ingredients	2007	4

As shown in Table 1, firms in the sample are rather young and small. Their age spans from 1 to 10 (reference year 2009) and their size varies between 3 to 44 employees (10 employees on the average).

Table 2 presents number of founders of and their joint research experience. As shown in Table 2, 8 of 12 firms (67%) were established by researchers belonging to the same institution who had participated in joint research activities before starting their own business. Obtained results indicate that an average ASOF is founded by 3 researchers.

Table 2: Number of founders and their joint research experience prior to starting their own business

Firm Name	*Number of founders and key personnel in the founding process*	*Same institution*	*Joint research experience*
Alpha Nano - Ceramics	4	No	No
Bravo Aeronautics	3	Yes	Yes
Charlie Audiotech	2	Yes	Yes
Delta Radars	n.a.	n.a.	n.a.
Echo Simulation	3	Yes	Yes
Foxtrot Nano - Materials	2	No	No
Golf Genetics	2	Yes	Yes
Hotel Biotechnology	5	Yes	Yes
India Magnetic Equipments	2	No	No
Juliet Vision Technologies	1	n.a.	n.a.
Kilo Advanced Materials	4	Yes	Yes
Lima Biochem	3	Yes	Yes

Table 3 presents the motivation of ASOF founders in starting their own business. As can be seen, ASOF founders attach greater importance to turning previous research into commercial products/services and commercialization of knowledge stock and previous research experience, whereas factors like licensing external technology and resale of products and services obtained from an external source are greatly neglected. Desire for personal success and independence, forming a more flexible research structure and advancing a research project already initiated at the parent institute also emerge as important factors.

Table 3: Motivation behind the foundation of ASOF (Likert scale 1 – 5)

Factors	*Mean*
Turning founders previous research into commercial products/services	4.75
Benefiting from a market opportunity	3.08
Forming a more flexible structure for research activities	3.33
Commercialization of knowledge stock and previous research experience of the founders	4.58
Utilizing or developing a technology licensed from an external source	1.17
Resale of products/services obtained from an external source (dealership agreements)	1.17
Desire for personal success and independence	3.58
High profit expectation from commercial activities	2.25
Desire to advance a research project previously started in the host institution	3.50

Table 4 displays the importance of founders' external linkages in the establishment process. Collaborative research activities with domestic and foreign universities or research institutions are rated as important factors in the founding process. Moreover consultancy services and carrying out collaborative research projects with other firms while working for the parent organization also appear to be substantial factors. On the other hand, Joint initiatives with non – government/non – profit organizations does not lay an important role in founders' external linkages in the establishment process.

Table 4: Importance founders attach to their external linkages before starting their own business (Likert scale 1 – 5)

Factors	*Mean*
Carrying out collaborative research projects with firms	2.92
Consultancy services for firms	3.33
Carrying out collaborative research projects with domestic universities/research institutions	3.67
Carrying out collaborative research projects with foreign universities/research institutions	3.75
Joint initiatives with non – government/non – profit organizations	1.50
Carrying out collaborative research projects with public institutions / providing consultancy services to public institutions	1.67

Table 5 shows the variety of innovative activities for the reference period 2006 – 2008. 9 of 12 firms claimed to have introduced products that are novel to the world. In addition 9 of 12 firms brought in both product and process innovations. All the firms in reported to perform in house R&D. However ASOFs seem to be reluctant in subcontracting their R&D activities. Moreover our results indicate that ASOFs are not keen to license external technologies and depend on internal knowledge stock for their innovative activities. On the other hand most of the firms stated to have machinery expenditure. Consequently it can be argued that ASOFs are more inclined to embodied technology transfer rather than formal technology licensing. 7 of 12 firms reported to have training and education spending, i.e. ASOFs are sensitive to replenishment of their internal knowledge stock. Our results indicate that 8 of 12 firms have marketing research expenditures, showing that ASOFs actively seek market opportunities for their products and services.

Table 5: Variety of innovative activities and innovation expenditures

	Product Innovations			*Process Innovations*		*Expenditures on innovation*						
Firm Name	*New to firm*	*New to market*	*New to world*	*Quality increasing/cost decreasing techniques*	*New method or technology*	*In house R&D*	*Outsourced R&D*	*Machinery and other equipment*	*IPR licensing*	*Training and education*	*Marketing research*	*Other*
Alpha Nano - Ceramics	yes	yes	yes	yes	yes	yes	no	yes	no	yes	yes	yes
Bravo Aeronautics	yes	yes	yes	yes	no	yes	yes	no	no	yes	no	no
Charlie Audiotech	yes	yes	yes	no	yes	yes	no	yes	no	yes	yes	yes
Delta Radars	yes	yes	yes	no	yes	yes	no	yes	no	no	no	no
Echo Simulation	yes	yes	no	no	no	yes	no	no	no	no	no	no
Foxtrot Nano - Materials	yes	yes	yes	yes	yes	yes	no	yes	no	no	no	no
Golf Genetics	yes	yes	yes	yes	yes	yes	no	no	no	no	yes	no
Hotel Biotechnology	yes	yes	yes	yes	yes	yes	no	yes	no	yes	yes	yes
India Magnetic Equipments	yes	yes	yes	no	no	yes	no	no	no	no	yes	no
Juliet Vision Technologies	yes	yes	yes	yes	yes	yes	no	yes	yes	yes	yes	yes
Kilo Advanced Materials	yes	yes	no	no	yes	yes	no	yes	no	yes	yes	yes
Lima Biochem	yes	no	no	no	no	yes	no	yes	no	yes	yes	yes

Table 6 depicts the clientele characteristics of ASOFs for the reference period 2006 - 2008. Half of the firms provide products and services to firms abroad, and most of them are active throughout the country. Confinement to the same city or region is not observed. Clientele of ASOFs are mainly composed of private firms. In addition most of these firms have past relations with ASOF founders. Public firms and institutions are seldom listed in the clientele list. Subcontracting and providing consultancy services to other firms are common revenue sources. On the average, subcontracting, test and calibration services and consultancy services to other firms account for 51.1% of ASOF revenues. Furthermore novel product sales account for 42.6% of ASOF's revenues on the average. Our results indicate that IPR licensing and resale of products and services obtained from an external source, which can be in system integration form, are not common modes of revenue generation in ASOFs.

Our results show that almost all the firms in our sample opted to locate their business close to universities. 8 of the firms reside in technoparks, 3 are hosted in incubators and only one firm is operating elsewhere. In Turkey, technoparks are established in university premises by law. In addition, incubators mentioned in this article are also situated within university borders and they belong to Small and Medium Sized Enterprises Development Organization (KOSGEB). As can be seen in Table 7, ASOFs' propensity to be in proximity with the hosting universities is mainly driven by the prospect of benefiting from government incentives. Easier access to research infrastructure and qualified human resources also appear to be important factors. Our results indicate that being close to clients and suppliers is not given as much importance as the ease of access to knowledge resources or abundance of cooperation opportunities.

Table 6: ASOF clientele and composition of sales

Firm Name	*Client*	*Previous linkage*	*Sale type*	*Client location*	*Product Sales (%)*	*Subcontracting in other firm's R&D project (%)*	*IPR licensing (%)*	*Test and calibration services (%)*	*Other consultancy services (%)*	*Resale of products and services (%)*
Alpha Nano - Ceramics	private firm private firm private firm	yes yes yes	product sale product sale consultancy	abroad abroad abroad	85	0	0	5	10	0
Bravo Aeronautics	private firm private firm	yes yes	subcontracting subcontracting	domestic domestic	20	20	0	20	40	0
Charlie Audiotech	public firm private firm	no yes	product sale subcontracting	same city abroad	60	10	0	0	10	20
Delta Radars	n.a.	n.a.	n.a.	n.a.	30	70	0	0	0	0
Echo Simulation	private firm public r&d ins.	yes yes	subcontracting consultancy	same city domestic	0	85	0	0	5	10
Foxtrot Nano – Materials	private firm private firm	yes yes	subcontracting subcontracting	domestic abroad	0	90	0	0	10	0
Golf Genetics	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Hotel Biotechnology	private firm	no	product sale	domestic	90	10	0	0	0	0
India Magnetic Equipments	public university private r&d lab	no no	product sale product sale	abroad abroad	98	0	0	2	0	0
Juliet Vision Technologies	private firm private firm private firm	yes no yes	product sale subcontracting product sale	same city abroad same city	50	20	10	0	0	20
Kilo Advanced Materials	private firm private firm private firm	yes yes yes	product sale subcontracting ipr licensing	abroad abroad abroad	25	65	10	0	0	0
Lima Biochem	public ins.	yes	subcontracting	domestic	10	40	0	40	10	0
Average					***42.6***	***37.3***	***1.8***	***6.1***	***7.7***	***4.5***

Table 7: Location choice of ASOFs (Importance attached to the reasons of location choice)(Likert Scale 1-5)

Firm Name	*Residence*	*Proximity to knowledge sources*	*Proximity to research infrastructure*	*Proximity to human resources*	*Benefiting from public incentives*	*Abundance of cooperation opportunities*	*Proximity to clients*	*Proximity to suppliers*
Alpha Nano - Ceramics	Technopark	1	3	2	5	5	5	5
Bravo Aeronautics	Incubator	5	5	5	5	4	2	3
Charlie Audiotech	Incubator	3	4	5	5	2	1	1
Delta Radars	Technopark	2	4	4	5	4	5	1
Echo Simulation	Technopark	4	4	4	5	4	4	2
Foxtrot Nano – Materials	Technopark	4	5	5	3	2	1	1
Golf Genetics	Incubator	1	1	1	5	4	1	1
Hotel Biotechnology	Other	1	5	5	1	1	1	1
India Magnetic Equipments	Technopark	1	1	3	5	1	1	1
Juliet Vision Technologies	Technopark	3	4	3	4	2	3	1
Kilo Advanced Materials	Technopark	5	5	4	1	2	1	1
Lima Biochem	Technopark	1	5	1	5	1	1	1
Average		***2.58***	***3.83***	***3.50***	***4.08***	***2.67***	***2.17***	***1.58***

All the firms reported to have some type of collaborative relation with other parties. Table 8 displays the importance attached to motivation behind collaboration with other actors. ASOF's mainly collaborate in order to perform joint R&D activities, develop new product and processes and share knowledge and skills with other partners. Depending on the results reported in Table 6, ASOF's play an important role in the innovation process of firms with which they collaborate, since most of the surveyed ASOF's reported significant revenues from outsourced R&D. On the other hand, ASOF's are reluctant to form partnerships for production.

Table 8: Motivations behind collaboration with other actors. (Likert scale 1 – 5)

Factors	*Mean*
To share knowledge and skills	3.6
R&D	4.0
Design	2.3
To acquire/To improve new technology	2.9
Production	1.9
To develop new products	4.0
Marketing	2.7
Education	1.7
Financing	2.2
To benefit from open information sources(such as exhibitions)	1.8

Profiles of the actors with whom ASOFs collaborate and their importance are presented in Table 9. "Customers" and "Public Institutions for financing innovations (TTGV, KOSGEB, DPT, and TUBİTAK)" are regarded as the most important partners, indicating that ASOF's are sensitive to customer demands and actively seek market niches. Financial incentives provided by funding agencies increase the importance their importance as collaboration partners. On the other hand, trade associations, private institutions for innovation finance and private consultancy firms are not rated as critical partners for collaboration. The founders of ASOFs in our sample claim that the main reason behind the low importance attached to collaboration with trade associations is the lack of active relationship with these associations. As can be seen in Table 9, ASOF's prefer public institutions over private ones. For collaboration, as seen from the figures, ASOFs prefer relationships with public institutions for innovation finance instead of private institutions. Additionally, for private consultancy institutes, the informants from ASOFs explicitly asserted that "we do not need such kind of consultancy. Because we established these firms to activate our specialization and expertise by commercialization of our knowledge accumulation. In that case, we do not need additional consultancy from private consultancy organization in our specialization. However consultancy in other areas than our specialization are needed."

Table 9: Profiles of the actors with whom ASOFs collaborate. (Likert scale 1 – 5)

Profiles	*Mean*
Suppliers	2.0
Customers	3.8
Competitors in the same sector	2.2
Competitors form other sectors	2.0
Universities	3.2
Public research institutes and public support institutions	2.4
Public Institutions for financing innovations (TTGV,KOSGEB, DPT, TUBİTAK)	3.7
Private Consultancy Institutes	1.5
Trade Associations (Chambers of Industry, Associations, TOBB, Chambers of Commerce…)	1.6
Private Institutions for financing innovations (Banks, Venture capital...)	1.6

In another question, we asked for the reasons that lead founders to collaborate with other firms/organizations. Among these reasons, the most important one is the expertise of the collaborated firms/organizations. This is an expected result for our sample firms. Because, these ASOFs are very small firms and they have small numbers of employees who are experts about their own subjects. Therefore, they are specialized in specific areas. In case of performing an activity that requires expertise other than theirs, this need leads founders of ASOFs to collaborate to perform this activity. Additionally, external relationships of the collaborated firms/organizations-such as other partners of the collaborated firms, the networks/groups the collaborated firms take part, the markets that the collaborated firms are active-are very important for ASOFs to collaborate with this firms. On the other hand, for the sample firms the factors of "Necessity of collaboration due to demand/market conditions" and "Long term collaboration/strategic collaboration with firms/organizations" do not play an important role in collaboration decision of the firm.

Table 10: Reasons that lead founders to collaborate (Likert scale 1-5)

Factors	*Mean*
Physical and intellectual resources of the collaborated firms/organizations	3.5
Expertise of the collaborated firms/organizations	4.2
External Relationships of the collaborated firms/organizations	3.7
Cost advantage acquired by collaboration	3.4
Necessity of collaboration due to demand/market conditions	3.0
Long term trust relationship with collaborated firms/organizations	3.4
Long term collaboration/strategic collaboration with firms/organizations	3.2

ASOF's were also requested to assess the obstacles and barriers to innovation. ASOF's innovative activities are hindered by financial constraints, followed by high innovation costs and inability to find qualified staff.

Table 11: Obstacles and barriers to Innovation (Likert scale 1-5)

Factors	*Mean*
Insufficiency of financial capital	3.8
Inability to obtain external financial resources	3.1
High innovation costs	3.3
Inability to find qualified employers	3.3
Insufficiency of required knowledge on technology	2.5
Insufficiency of knowledge about market conditions	2.5
Low possibility of collaboration	2.1
Monopolistic tendencies of dominant enterprises in markets	2.6
Uncertainty about the demand for new goods/services	2.8
Uncertainty in domestic and world economies	3.2

In the final part of the questionnaire, ASOF's were asked to assess the importance of non – technical, i.e. organizational and marketing innovations. Obtained results indicate that ASOF's are actively seeking new methods to improve their efficiency, while they are less concerned with new organizational set-ups or marketing techniques. This finding is comprehensible, since ASOF's are serving to niche markets with low marketing requirements.

Table 12: Importance attached to Non-Technical Innovations (Likert scale 1-5)

Factors	*Mean*
Use of new and/or improved techniques to obtain more benefit from knowledge and skills of the enterprise	3.1
Change in organizational structure of the tasks	2.8
Use of new and/or improved techniques in relationships with other enterprises and/or organizations	2.5
To change design and /or the package of the products	2.7
Use of new and/or improved techniques in marketing and distribution of the products	2.5

5. Discussion of Results

Performance of statistical inference tests was restrained due to small sample size. However validity of arguments put forward in Section 4 can be speculated by interpreting the observed trends and proclivities.

Argument 1 supposes that founders of ASOFs have similar research orientation and form research groups, which operate like a quasi –firm. Our results indicate that 8 of 12 firms were established by researchers belonging to the same institution who had joint research background. Researchers with analogous affinities come together and combine their research efforts in order to achieve common goals. They assume managerial duties in addition to their researcher role, assemble teams from their subordinates, and coordinate the joint research activities of the group (Etzkowitz, 2003). Since a clear majority of researchers in this study have cooperative research background, it can be concluded that Argument 1 is valid for the sample of ASOF's surveyed in this study.

Argument 2 suggests that founders of the ASOF anticipate the commercial benefits of their research results. Obtained results indicate that ASOF founders attach greater importance to turning previous research into commercial products/services and commercialization of knowledge stock and previous research experience. This finding shows that ASOF founders are aware of the commercial value of their research results and their existing stock of knowledge and they want to evaluate this commercial value by establishing spin-off firms. Therefore, researchers who anticipate the commercial value of their work are more inclined to establish their own business. Consequently Argument 2 can also be regarded as valid and it should be further tested with statistical inference tests. However endogeneity problem should be addressed in this process.

Argument 3 is built on the premise that the ASOF founders have personal ties to industry. As shown in Table 4, consultancy services and carrying out collaborative research projects with other firms while working for the parent organization appear to be substantial factors in the ASOF founding process. Moreover our results show that most of the ASOF clientele for the reference period of 2006 – 2008 have precedent relations with ASOF founders. Thus we consider Argument 3 as valid.

Argument 4 pertains to the knowledge transformation function of ASOFs. Argument 5 is based on the idea that ASOFs provide important inputs to other firms' innovative activities. As shown in Table 4, collaborative research activities with domestic and foreign

universities or research institutions are rated as important factors in the founding process of ASOFs. In addition, subcontracting and providing consultancy services to other firms are common revenue sources for ASOFs. Although ASOFs do not have the tendency to license external technologies, most of the firms in our sample report having machinery and other innovation related equipment expenditures. This condition can be inferred as ASOFs preference towards embodied technology transfer rather than formal technology licensing. Moreover 9 of 12 firms in our sample report having introduced products that are novel to the world. Accordingly it can be argued that ASOFs combine their existing knowledge stock with knowledge obtained from external sources, typically parent institutions and other universities and provide product and services to their clients. In this context ASOFs emerge as important input suppliers to other firms' innovative activities. Results of our study conform with the findings of Autio(1994) and Laranja and Fontes (1998). Thus we claim Argument 4 as valid, but the knowledge transformation process taking place within the ASOF should be further investigated.

Argument 6 is related to the location preference of ASOFs. Almost all of the firms encompassed in our study are established within university premises, operating either in technoparks or incubators. Surprisingly most of these firms point benefiting from public incentives as the most important factor in their residence decision. In Turkey, substantial amount of public resources have been devoted to create and sustain university – industry linkages. However our results signal the substitution of "means" with "ends". On the other hand firms in our study also report benefiting from research infrastructure and qualified personnel pool offered by the hosting institutions. Our results do not provide enough evidence to validate or falsify this argument.

6. Foundation and Initial Development Phases of ASOFs

Drawing upon our findings, we can make some generalizations about the foundation and development phases of ASOFs. In the initial phase, academicians with similar research interests and backgrounds form a research group, which operates like a quasi – firm as explained above. Utilizing their existing knowledge stock combined with novel knowledge flow from other research institutions, these academicians provide consultancy services to other firms and partake in collaborative R&D projects. Research group benefits from universities infrastructure and human resources pool in this phase. Linkages formed in this phase pave the way for the foundation of ASOF.

A schematic representation of this process is given in Figure 1.

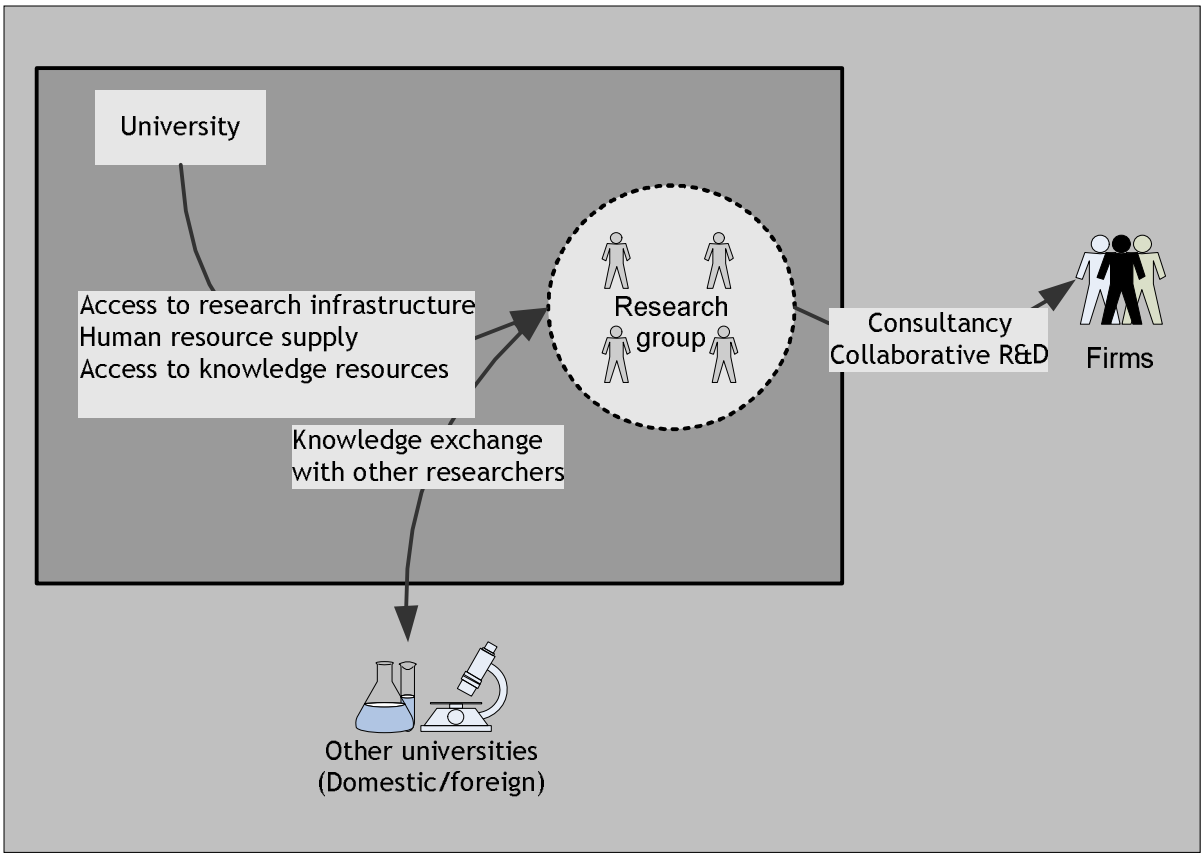

Figure 1: Establishment phase

There are various driving factors behind the establishment of an ASOF, key dynamics being commercialization of previous research and knowledge stock of founders. It can be argued that through their interaction with other firms and knowledge providers, ASOF founders become aware of the commercial value of their research results and decide to start their own business. Naturally firms, which have previous relations with ASOF founders, form the main body of clientele. ASOF remains physical proximity with the university, benefiting from its research infrastructure and qualified personnel pool and also takes advantage of various public incentives to form university – industry linkages. ASOF's knowledge stock is replenished with knowledge flow from hosting institution as well as other research bodies. Moreover ASOF upgrades its infrastructure by investing in innovation related machinery and equipment. ASOF also actively seeks new marketing opportunities and tries to extend its clientele spectrum.

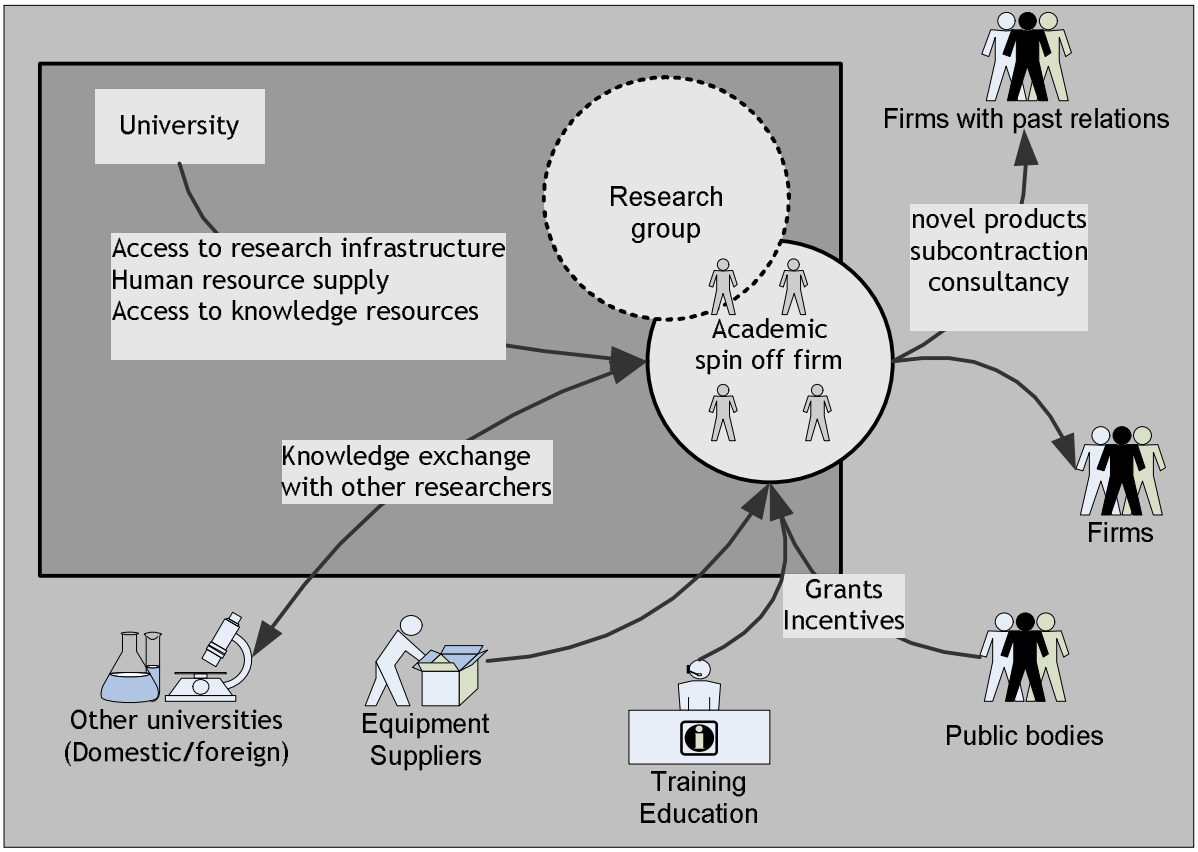

Figure 2: Development phase of ASOF

As can be seen in Figures 1 and 2, ASOFs relationships with other parties evolve over time. Change in the characteristics and number of linkages affects the development of ASOF. An interactive process takes place, in which evolving linkage characteristics shape ASOFs profile and maturing ASOF seeks to form new relations with other parties. The strength, concentration and stability of these relations define ASOF's embeddedness in this network (Yli - Renko and Autio, 1998).

7. Conclusion:

In this study, it is intended to understand commercialization of academic knowledge through new enterprises established by researchers, i.e. academic spin – off firms (ASOFs). ASOFs, as a subset of NTBFs, are the companies which evolve from universities through commercialization of intellectual property and transfer of technology developed within academic institutions. Building upon this definition, a questionnaire survey was prepared targeting a sample of ASOFs from different sectors in Turkey. The main objectives were to determine the factors that drive academic researchers to establish their own enterprise, and to search for the role of ASOFs in other firms' innovative activities.

Policies towards the commercialization of university research can be developed by two different alternatives (Goldfarb and Henrekson, 2003). These policies can be generated by

either focusing on creating (economic) incentives for universities to commercialize their research output and allowing them to experiment to find the best means to do that or the government directly creates mechanisms that facilitate commercialization. In first alternative, researcher are directly motivated to be included in commercial activities by their own efforts. For this purpose, universities are supported to set up their own technology transfer offices to use commercial opportunity instantly by their own methods. This creates freedom for researchers, but additional consultancy support (such as management consultancy, organization structuring) should be provided to researchers to complete their lack of experience in commercial activities. One step further, if the university points "mission of entrepreneurialism" as a priority, this university can shape its institutional structure compatible to this mission. For example university can develop organizational innovations to achieve synergy between basic research, applied research, teaching, and cooperation with industry. Moreover, if the university can prioritize research interests & abilities compatible to commercialization of the research in specialized disciplines and technology areas and can improve the skills of generating an institutionalized capacity for strategic selection of research agenda by these priorities, this university can harmonize its scientific competences and professional managerial competences. Hence a professional and institutionalized external environment for commercialization of research results can be created to support the establishment and development of ASOFs. For this purpose, first of all, the university should realize its potential in research and new technology development and should analyze the extent of academicians and researchers personal ties to industry. Then if these are eligible to be an entrepreneurial university, university may define entrepreneurialism as a priority and may adapt its organization and infrastructure in compatible with this prioritized mission to provide such an environment for new ASOFs to establish and existing ones to develop.

ASOFs in our sample employed 10 people on the average, this figure points out their small sizes. Consequently it would be naïve to offer the employment generation role of ASOFs adducing a few successful enterprises like Hewlett – Packard, Google etc. ASOFs are instrumental in creating quality jobs, but the number of jobs generated is limited. For the purpose of new job creation, policies should be directed towards increasing the number of ASOFs rather than focusing on a few rapid growing examples.

Our results indicate that founders of ASOFs have similar research orientation and form research groups, which operate like a quasi –firm. Moreover the main motivation behind establishment of ASOFs is to turn founders' previous knowledge stock and research experience into commercial products/services to obtain commercial benefit. Former personal linkages to industrial partners pave the way for new venture formation.

Furthermore collaborative research with other universities also adds to the knowledge stock of researchers. These findings require a closer investigation of some policy considerations. First, ASOF founders depend on their existing knowledge stock and research experience while starting their own business, indicating the crucial role of new knowledge production within universities. This can be achieved by directly supporting basic research projects on a competitive basis and investing in research infrastructure of universities. Moreover new knowledge production may be facilitated by university through the mission choice of serving to society, innovation and technology transfer processes as a priority. Because the entrepreneurial university can realize this mission to connect university and industry by establishment of ASOFs for whom commercialization of research results is an important founding motivation. In addition to knowledge production, knowledge transformation function of ASOFs can be accepted as a premise of an entrepreneurial characteristic emerges at university level, so to say *a capacity to contribute to the development of new industries*. Because ASOFs transform the knowledge produced in the parent university and relay it to market by means of products and/or services and they provide inputs to other firms' innovations. These functions of ASOFs cause university to build capacity for development of new industries and transform the parent university to an entrepreneurial university by supporting additional structural and organizational changes.

In addition to researchers' participation in collaborative research activities, the knowledge inflow derived by these collaborations also add to the intellectual capital of ASOFs. Because for ASOF founders, personal ties to industry are very important in new venture formation process. It can be argued that researchers who are prone to develop ties or who have the personal traits to form such linkages to industry are more inclined to establish their own business. On the other hand more opportunities are revealed to researchers as they are involved in collaborative research activities with industry. In either case, researchers should be encouraged to partake in joint research activities with industry; hence they can realize the commercial value of their knowledge stock and research experience. This can be achieved in a professional entrepreneurial environment in the university where academicians' personal ties to industry that lead those to establish their own business are institutionalized by an *expanded developmental periphery*. This periphery constitutes professional organizational structures that ease to outreach university borders and cooperate with outside organizations and groups in industry. Also, another structural unit in the university, *steering core for industrial dynamics*, may be more useful for academicians for whom collaborating with industrial partners is important. This unit can provide more professional and organized way of management for construction

and survival of these personal ties to industry thus can facilitate the founding process of ASOF. Moreover IPR regulations can be redesigned in favor of researchers in order to ease the commercialization of academic knowledge

Our findings suggest that ASOFs provide important inputs to other firms' innovative activities either in the form of knowledge transfer or supply of sophisticated products. Contrary to often mentioned rapid growing new technology-based firms, ASOFs assume the role of technology intermediaries especially in developing countries. ASOFs acquire external knowledge and combine it with their internal stock and provide other firms novelties developed within the ASOF. In this process, a problem emerges because ASOFs evolve from non-commercial environments and have to overcome substantial obstacles on the way to become a profitable organization. This can easily be solved by the role of parent university in this process. If the university defines entrepreneurialism as a priority and establishes *a university based non-commercial organization* to solve the incompatibility problem of ASOF and industry, this university can create a professional commercialization intermediary service by this unit and can provide an *interface between ASOF and industry in technology and knowledge transfer*. By this new organizational structure, possibility of conflicting interests of key stakeholders of ASOFs (i.e. the academic entrepreneurs, university management, finance suppliers etc.) can be eliminated. As another suggestion for universities, provisions may be taken for university technology transfer offices to extend their services to ASOFs.

A striking finding of our study is that most of the ASOFs reside in university premises in order to benefit from public incentives like tax relieves and rent subsidies rather than being close to knowledge sources or potential clients. Our results indicate a substitution of "means" with "ends". In order to eliminate this substitution, public incentives can be provided temporarily and on a conditional basis, requiring the constant interaction of firms and hosting institutions. Additionally, if the parent university decided to be an entrepreneurial university and can create a diversified funding base to widen its financial resource portfolio and to find alternative funds other than government funds, this financial diversification can create more options for ASOFs. Hence, location choice may not be determined by the factor of benefiting from incentives. In such case, ASOFs do not need to substitute means with ends and location preference can heavily depend on *research factors* such as proximity to knowledge sources, proximity to research infrastructure and proximity to human resources and *market factors* such as abundance of cooperation opportunities, proximity to clients and proximity to suppliers rather than *monetary factor* of benefiting from public incentives

Our study encompassed 12 out of 30 ASOFs, upon which it is not possible to conduct statistical inference tests or other modeling exercises. A higher number of firms can be targeted in future studies and the content of the questionnaire can be enriched in order to highlight the knowledge transfer function of ASOFs. Moreover a comparison of NTBFs from other origins and ASOFs can be made for the purpose of identifying distinct formation and development phases.

8. References

Audretsch, David B.; Erik E. Lehmann and Susanne Warning (2005) "University spillovers and new firm location", *Research Policy,* 34,pg.1113–1122

Autio, Erkko (1994), "New, technology-based firms as agents of R&D and innovation: an empirical study", *Technovation,* 14, pg.259-273

Autio E., Yli – Renko, H., (1998), "New, technology-based firms in small open economies—An analysis based on the Finnish experience", *Research Policy*, 26,pg. 973 – 987

Bollinger, L., Hope, K., Utterback, M., (1983), "A review of literature and hypotheses on new technology-based firms", *Research Policy*, 12, pg.1- 14

Carayannis, Elias G.;Everett M. Rogers, Kazuo Kurihara and Marcel M. Allbritton (1998) , "High-Technology spin-offs from government R&D laboratories and research universities", *Technovation,* 18(1),pg. 1–11

Chiesa, Vittorio and Andrea Piccagula(2000) , "Exploitation and Diffusion Research: The Case of Academic Spin off companies in Italy", *R&D Management*, 30, 4, pg. 329-339

Cooper, A. C. (1972). Spin-off companies and technical entrepreneurship, IEEE Transaction onEngineering Management, 1:EM-18.
Clark,B.R. (1998), "The Entrepreneurial University: Demand and Response", *Tertiary Education and Management*, Vol.4, No.1, 1998, pg. 5-16

Djokovic, D., Soutaris, V., (2008), "Spinouts from academic institutions: A literature review with suggestions for further research", *Journal of Technology Transfer*, 33, pg. 225-247

Etzkowitz, H., (2003) "Research groups as 'quasi-firms': The invention of the entrepreneurial university", *Research Policy,* 32, pg. 109-121

Gibb, A and P. Hannon (2006), "Towards the Entrepreneurial University?", https://webspace.utexas.edu/cherwitz/www/articles/gibb_hannon.pdf

Goldfarb, Brent and Magnus Henrekson (2003), "Bottom-up versus top-down policies towards the commercialization of university intellectual property", *Research Policy,* 32, pg. 639–658

Gören, Hüseyin (2008), "Testing Additionality Effect of Tübitak's Industrial R&D Projects Funding Programme: Pilot study on Software Development Sector in Ankara [Electronic resource] ", Supervisor Assoc. Prof. Dr. Erkan Erdil, Unpublished MS Thesis.

Jacob, M., M. Lundqvist and H. Hellsmark (2003), " Entrepreneurial transformations in the Swedish University system: the case of Chalmers University of Technology", *Research Policy*, 32, pg. 1555–1568

Johansson, Mattias, Merle Jacob and Tomas Hellstro (2005), "The Strength of Strong Ties: University Spin-offs and the Significance of Historical Relations",*Journal of Technology Transfer*, 30, pg. 271–286

Landry, R´ejean, Nabil Amara and Imad Rherrad (2006), " Why are some university researchers more likely to create spin-offs than others? Evidence from Canadian universities", *Research Policy*, 35, pg. 1599–1615

Lazzeretti, L and E. Tavoletti(2005), " Higher Education Excellence and Local Economic Development: The Case of the Entrepreneurial University of Twente", *European Planning Studies,* Vol. 13, No. 3, pg. 475-493

Lehrera , M., P. Nell and L. Gärberb (2009), "A national systems view of university entrepreneurialism: Inferences from comparison of the German and US experience" *Research Policy,* 38, pg. 268–280

Krabel, S. and P. Mueller (2009) , "What drives scientists to start their own company? An empirical investigation of Max Planck Society scientists", *Research Policy*, 38,pg. 947-956

Kroll, Henning and Ingo Liefner (2008), "Spin-off enterprises as a means of technology commercialisation in a transforming economy—Evidence from three universities in China", *Technovation* , 28, pg.298–313

Laranja, M. and Fontes, M., (1998), "Creative adaptation: the role of new technology-based firms in Portugal", *Research Policy*, 26, pg. 1023 – 1036

Mets, T. (2010), "Entrepreneurial Business Model for Classical Research University", *Inzinerine Ekonomika-Engineering Economics*, 2010, 21(1), pg.80-89

Mustar,Philippe, Marie Renault, Massimo G. Colombo, Evila Piva, Margarida Fontes, Andy Lockett, Mike Wright, Bart Clarysse, Nathalie Moray (2006), "Conceptualising the heterogeneity of research-based spin-offs: A multi-dimensional taxonomy", *Research Policy* , 35, pg. 289–308

Pirnay, F., Surlemont, B., Nlemvo, F., (2003), "Toward a typology of university spin-offs", *Small Business Economics*, 21, pg. 355-369

Roberts, E. B., (1990), "Strategic transformation and the success of high technology companies", Working papers WP #2-90, Cambridge, Massachusetts: Massachusetts Institute of Technology, Sloan School of Management.

Roberts, E.B., Peters, D.H. (1981), "Commercial innovation from university faculty", *Research Policy*, 10, pg. 108-126.

Rothaermel, F.T., Agung, S.D., Jiang, L., (2007), "University entrepreneurship: A taxonomy of the literature", *Industrial and Corporate Change*, 16, pg. 691-791

Storey, D.J., Tether, B.S., (1998), "New technology-based firms in the European Union: an introduction", *Research Policy*, 26, pg. 933-946

Utterback, M., Abernathy, W., (1975), "A dynamic model of product and process innovation", *Omega*, 33, pg. 639 – 656

Yli – Renko, H., Autio E., (1998), "The network embeddedness of new technology-based firms: Developing a systemic evolution model", *Small Business Economics,* 1998, 11, pg. 253 – 267

Zaharia , S.E. and E.Gibert (2005) "The Entrepreneurial University in the Knowledge Society, *Higher Education in Europe*, Vol. 30, No. 1., pg.31-40