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How do ICT firms in Turkey manage innovation?
Diversity in expertise versus diversity in markets

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Abstract

This paper provides a novel taxonomy of firms based on specialisation versus diversification in production and markets. Firms may chose to specialise on few production activities or alternatively may build expertise in many activities. There is an accompanying decision when firms sell their products: whether to serve few or many markets. We argue that the location on the specialisation-diversification spectrum significantly affects how firms manage innovation. For a sample of 90 innovator ICT firms in Ankara we find that cooperation structure, sources of innovation and funding of R&D display statistically significant different patterns according to the specialisation-diversification taxonomy.

Key words: management of innovation, core competency, expertise building, R&D, ICT
JEL: O32, L22, L86

1. Introduction

Firms use different strategies to manage innovation. Firm resources, market structure and the size of the firm play crucial role in forming firm strategies. The resource based view (e.g., Wernerfelt, 1984), dynamic capabilites (e.g., Teece, Pisano and Shuen, 1997) and core competence (e.g., Prahalad and Hamel, 1990) literatures discuss how combining unique firm resources and capabilities can leverage the competitive position of the firm.

In this paper we investigate the innovation management strategies of Information and Communication Technologies (ICT) firms in Ankara. ICT firms face an environment where the rate of technological change is high, product cycle is short and competition is high. In such an environment keeping competitive position requires strategies that are carefully built towards survival and growth. These strategies are made of bundles of firm specific decisions that are crucial in benefiting from various opportunities in the ICT sector.

We provide a novel taxonomy of firms based on the decisions in production and markets using data from ICT firms in Ankara. We view specialisation or diversification in production and markets as important firm decision. Firms may build expertise in a number of fields thus specialise on a core technology field or diversify and acquire knowledge in many related subfields. We refer to this as the specialisation-diversification decision in production. In a similar way firms may serve to limited number of markets or to many markets. We refer to this as the specialisation-diversification in markets. Previous research has focused on the specialisation-diversification in either production or markets (e.g., Varadarajan and Ramanujam, 1987; Hoskisson and Hitt, 1990; Markides and Williamson, 1994; Cantner and Graf, 2004). With respect to ICT sector Granstrand, Patel and Pavitt (1997) show that firms do have core competencies in production but also diversify within the ICT sector. As such firms may have "distributed" rather than "core" competencies. According to our knowledge there is no work that attempts the merge specialisation-diversification decisions in both production and markets. The interplay of both could enhance our understanding in how firms organise production and innovation.

We argue that the position of firms in specialisation-diversification taxonomy is an important determinant of how firms manage innovation. Thus we expect that firm organisation, cooperation structure, sources of innovation and funding of R&D differ according to this taxonomy. To clarify our argument we can look at the following example. About 50 percent of the ICT firms in Ankara have expertise in one or two fields. Among a set

of 40 expertise fields such as embedded system design, nanoelectronics and photonics, one-quarter of the firms are active in only one field and produce only one or two products. On the other end of the spectrum there are multi-product firms that diversify production and markets. 10 percent of the firms have expertise in more than 10 fields and produce on average 20 products. On the specialisation-diversification spectrum of production and markets numerous firms operate with different strategies to maintain competitiveness. As an important channel to maintain competitiveness we argue that innovation strategies cannot be independent from the location on the specialisation-diversification spectrum.

To investigate the idea sketched above we first explain our taxonomy in detail and group firms into four groups: core-specialised firms, diversified firms and two intermediate groups. Our empirical framework is build on comparing groups to see whether there are statistically significant differences among groups regarding key firm characteristics, cooperation structure, R&D funding and sources of innovation. Moreover we select four firms that represent each group and investigate these firms in a detail manner. So we not only present statistical comparisons but also support our findings with a field work investigating four representative firms in detail. We show that for a sample of 90 ICT firms located in Ankara the extent of cooperation, funding of R&D and sources of innovation are different in core-specialised firms compared to multi-product firms that diversify production.

This research contributes to the existing literature in at least three ways. First we present a novel taxonomy of firms based on the decision to specialise or diversify production and/or markets. We think that this approach provides a more lucid understanding on the differences in firm organisation and the management of innovation. Second, we use detailed micro data on firm organisation and innovation from an emerging market such as Turkey. The case of Ankara is interesting because Ankara has emerged as a major player in ICT and electronics sector in Turkey. Current figures show that about 50 percent of all technology-zone R&D personnel employment in Turkey is in Ankara. Given this there is hardly any study that map the ICT sector in Ankara. One particular interesting point is that all firms in our sample are innovators. Thus we can assess firm strategies towards managing the innovation process. Finally, our questionnaire design is novel in the sense that we collect detailed information on the production of firms, technological fields they focus on and markets they serve.

This paper is structured as follows. Section 2 discusses the related literature briefly. Section 3 presents the specialisation-diversification taxonomy. We explain our empirical strategy in section 4. The following section presents the empirical results and the accompanying firm cases. Section 6 concludes.

2. Background Literature

Firms need to innovate and maintain product variety to meet diversified customer needs. In such an environment firms may implement different innovation management strategies. In this paper we argue that the decision to diversify expertise and/or markets is a key determinant in shaping different innovation management strategies. This argument could be framed within the sources of innovation literature (e.g., Von Hippel, 1988). The fact that firms have diverse sources of innovation has major consequences for the management of innovation both with respect to the organization of R&D and building competitive advantage. The main ideas in this paper that can be embedded in the source of innovation literature are mainly related to three inter-connected literatures: resource based view (e.g., Penrose, 1959; Wernerfelt, 1984), dynamic capabilites (e.g., Teece, Pisano and Shuen, 1997), and core competence (e.g., Prahalad and Hamel, 1990). These literatures discuss the importance of combining unique firm resources and capabilities in an efficient way to leverage the competitive position of the firm.[1]

Resource-based view (RBV) links firm's own resources with its performance. RBV assumes that firm infrastructure, which is not easily substitutable, is the main source of competitive advantage (Wernerfelt, 1984; Peteraf, 1993; Barney, 2001). Grant (1991) separates the "infrastructure" into the three categories of tangible, intangible and personnel-based resources. Financial resources and physical infrastructure represent firm's tangible resources, while reputation and product quality are considered to be intangible. Personnel-based resources are further broken down into technical know-how, organizational culture and employee training. In this paper we mainly investigate the importance of tangible resources (e.g., funding of R&D) and technical know-how (e.g., technological expertise) in managing the innovation process. Section 5 utilizes these ideas and investigate whether firm resources that are used in innovation differ in terms of production and marketing strategies of the firms.

[1] This line of research is also related to the heterogenous firms view of the evolutionary economic theory (e.g., Nelson and Winter, 1982). Because the concepts of resource, capability and (core) competence are not readily defined there is an inherent ambiguity especially in practically applying these concepts (Drejer, 2000; Hafeez, Zhang and Malak, 2002; Ljungquist, 2007). One inherent problem in the discussion of resources, competences and capabilities is the measurement. Newbert (2007) concluded that capabilities and core competencies are more important in explaining competitiveness than resources. However, resources have received much empirical attention since resources are easier to identify and measure, while capabilities and core competencies are difficult to access and identify (Trott, Maddocks, and Wheeler, 2009). Even sometimes these concepts are used interchangably (e.g., Spanos and Prastacos, 2004).

Albeit the usefulness of the RBV in explaining the competitiveness of the firm, mere existence of unique firm resources are not considered to be focal because value is created when resources are utilized in innovative ways, and what makes the difference is the way the firm utilizes its resources (i.e., firm strategies). Teece and Pisano (1994) define this process as the implementation of firm strategies in two ways. The first focuses on compatibility between the technology and internal capabilities and the second highlights the importance of building strategies that suit the firm's environmental conditions. According to the comprehensive version of the RBV resources are translated into overall firm performance by means of organizational skills which are also referred as the firm's "dynamic capability".

Dynamic capability is defined as the ability of the firm to align resources and competences to enhance competitiveness in a changing environment (Teece and Pisano, 1994; Teece, Pisano and Shuen, 1997). Doving and Gooderham (2008: 845) conceive dynamic capabilities as "enduring routines, systems, and processes that are visible, known, and managerially intended as a means to achieving new resource configurations". Describing dynamic capabilities as ability utilizing opportunities for firms to capture value Teece (2010) emphasize that in a successful innovation process firm's capabilities have to cooperate with the eco-system. In this paper, we view dynamic capabilities as the ability of managing the innovation process by determining strategies to adapt to changing external business environment.[2] According to this approach, resources, capabilities and competences are integrated and reintegrated so that they are tuned in to the business environment (e.g., Teece, 2007). In order to build the dynamic capabilities, the firm is required to sense (i.e. identify and assess an opportunity) and seize (i.e., mobilization of resources to capture value) opportunities for new technologies or markets, as well as to successfully reallocate its resources or develop new ones (Kim, Lim and Park, 2009; Teece, 2010).

The core competence literature approaches the competitiveness problem from another angle. According to this literature the resources and capabilites have to be succesfully integrated to result in sustainable competitive advantage (Hafeez, Zhang and Malak, 2002) and as such understanding core competencies are vital for exploiting firm's resources (Javidan, 1998). So what creates value added is not the unique assests and resources of the firm but the efficient integration of these assets and resources. Prahalad and Hamel (1990: 82) defines core competency as "the collective learning in the organisation, especially how to coordinate diverse production skills and integrate multiple streams of technology". Core

[2] Our understanding is also related to the concept of technological capabilities (Bell and Pavitt, 1993).

competences are the pool of experience, knowledge and systems that exist elsewhere in the firm and can be deployed to reduce costs or time required either to create a new strategic asset or expand the stock of an existing one (Markides and Williamson, 1994).

Core competence concept is an important contribution to the strategic management literature. However core competence is a challenging concept in terms of conceptualisation, identification and empirical validation (Clark, 2000; Eden and Ackermann, 2000; Ljungquist, 2007). It is for this reason that we have a more down-to-earth understanding of core competency. In this paper we view core competencies as expertise that firms may build on a variety of fields that are used in the production process. Firms typically possess core competence in the production of a particular variety and that they are less efficient in the production of varieties outside their core competence (Eckel and Neary, 2010). The study that comes closest to our understanding of core competence is Duysters and Hagedoorn (2000). To investigate the impact of core competence on firm performance they limited the concept to an empirically applicable technological specialisation-diversification framework. If the firms' patent activity mostly falls under a limited number of patent class these firms are classified as specialised firms (i.e., specialised in the utilisation of few industrial activities). On the other hand firms' may conduct research on many related areas (patents in many different patent classes).[3] In a similar vein Grandstand, Patel and Pavit (1997) and Rao, Vemuri and Galvin (2004) investigated the specialisation-diversification decision in ICT firms by looking at the patent data. They found that core competence is important but firms increasingly diversify within the ICT sector but not outside the ICT sector. The treatment of core competence in the original Prahalad and Hamel (1990) is also close to our approach. For instance, Canon's core competence in precision mechanics and micro-electronics resulted in a variety of products that could be sold in various markets. Thus specialising or diversifying on core competencies is a strategic firm decision that depends on many parameters such as size, human capital, and sector.[4] To give a specific example, a firm that conducts innovation on personal health systems may choose to build competence on a variety of fields such as technology enhanced learning, information management, trustworthy ICT and virtualisation. On the other hand the firm can specialise and build expertise only on a limited number of fields and outsources the rest. As such the specialisation versus diversification decision in the production process determines the innovation management strategy of the firm.

[3] This measure is also related to earlier studies on technological revealed comparative advantage to measure specialisation of a countries and regions. See for instance Laursen (1998).

[4] For instance Hoskisson and Hitt (1990) argue that diversification decision is a direct consequence of the deployment of surplus intangible resources.

3. Data and Methodology

Data on the ICT firms is collected in 2011 as a part of a project funded Ankara Development Agency. Located in the middle of the country Ankara is the capital city of Turkey with about 4.9 million inhabitants. Almost all companies we interviewed are located in a technology park in one of the three large campus universities –Middle East Technical University (METU), Bilkent University and Hacettepe University. These three universities are approximately 5-10 minutes away from each other (by car) and form a research and technology triangle with about 60,000 students and 2,000 university researchers. 550 firms established in these three technology-parks (METU-TECH, Bilkent-CYBERPARK and Hacettepe-Technopolis) employ about 5,500 researchers that correspond to about 50 percent of all technology-zone R&D personnel employment in Turkey. About 80 percent of these firms operate in software, telecommunication and electronics sectors.[5] Within the past decade Ankara has emerged as a major player in ICT and electronics sector. Our survey covers 90 innovator ICT firms which is about 20 percent of ICT related firms in the three technology parks in Ankara. The firms in our sample employ 3,150 employees which corresponds to 46 percent of all employment in the three technology parks mentioned above.

The questionnaires were conducted face-to-face with the owner or the manager of the firms and took on average one hour. In some cases an expert engineer was present in the meetings. The questionnaire included questions on firm organisation, R&D, innovation and human capital of the firm. We collected detailed data on the sector that the firm operates and the core production activities of the firm as described in section 2. This information can be used to analyse whether the firm specialises or diversifies in production. The questionnaire was applied to 101 firms but since some firms did not answer some questions we base our analyses on the available information from 90 firms. Table A.1 in the appendix presents the descriptive statistics.

Our empirical methodology is based on a taxonomy of specialisation-diversification decision in production and markets. The firms may specialise on a limited number of core activities or could choose to build competence in many diversified technical fields. By the same token firms can serve to a limited number of markets or could sell its products in many

[5] The information presented in this paragraph is gathered from a leaflet of Ankara Development Agency. Accessed 21.07.2012 http://www.ankaraka.org.tr/tr/files/yayinlar/osbler-teknoparklar-ve-ankara.pdf

markets. This taxonomy is discussed further in section 4. After we associate each firm to a group on the specialisation-diversification frontier (see section 4) we analyse group specific characteristics.

The aim of the paper is to see whether firms grouped according to the taxonomy above have different innovation management strategies. To investigate this we used two methods. We first considered key indicators such as age, employment, R&D and innovativeness and statistically analysed differences among groups. We test whether variances in two groups are equal and then conducted variable-by-variable two-sample mean comparison tests. We test the null hypothesis that the mean difference between the two groups is zero against the alternative that the mean of one group is statistically different (higher or lower) from the mean of the other group. In this way we specifically know which groups differ in which variables. Section 5.1 presents the results of this exercise.

Management of innovation is analysed under three headings: cooperation structure of firms, sources of innovation, and funding of innovation. These headings fit well with the dynamic capabilities and RBV literature we briefly touched upon in section 2. Cooperation structure includes nine questions asking firms the importance of cooperation with other firms, consumers and suppliers regarding R&D, design and innovation. Then we have a set of questions that specifically asks the sources that the firm benefit from in the innovation process. Firms could use a wide set of resources such as firm specific knowledge, other's expertise, patents etc. Finally we ask the sources of R&D funding which range from own funds to government R&D subsidies. All questions described briefly above use a likert scale from 1: not important at all to 5: very important. We also use variable-by-variable mean comparison tests to statistically analyse the differences among groups.[6] In section 5.2 we briefly sketch the distinctive elements of each group using the taxonomy in section 4.

Finally we select representative firms from each group and compare firms on the grounds of how they manage innovation (section 5.3). In this way we can reflect some of the interviewer specific knowledge that we gathered in the field. The firm cases can also be viewed as a detailed robustness exercise.

4. Taxonomy of ICT firms

[6] We could alternatively compare groups on the basis of the indicator set using MANOVA. However this tells us whether two groups differ on the indicator set, but not which indicators cause this difference. So for instance cooperation structure of core-specialised firms is different from diversified firms but we do not know which cooperation element drives this result. It is for this reason that we used a variable-by-variable comparison strategy.

Do firms that specialise in few core technological fields differ from their counterparts that diversify production and market activity in terms of how they manage the innovation process? In this section we present a taxonomy of ICT firms that will assist us to answer this question. We base the taxonomy according to firm's degree of diversity in production and markets. We consider two main and two intermediate groups and argue that the firms belonging to different groups manage innovation in different ways.

As we have emphasized in the introduction one of the novelties in our data set is that we have detailed information regarding the technological activities of the firm and the sectors that the firm operate. We asked firms to specifically state research areas of core expertise. The firms could choose from 40 fields such as cognitive systems and robotics, software and virtualisation, nanoelectronics, intelligent information management etc.[7] Moreover we asked the sectors that firms operate (i.e., the sectors that they sell their products). Firms choose from 13 sectors: ICT, health, transportation, environment, culture and sports, education, defense industry, manufacturing, energy, wholesale services, tourism and consultancy.

Figure 1: Taxonomy of ICT firms according to sector and research fields

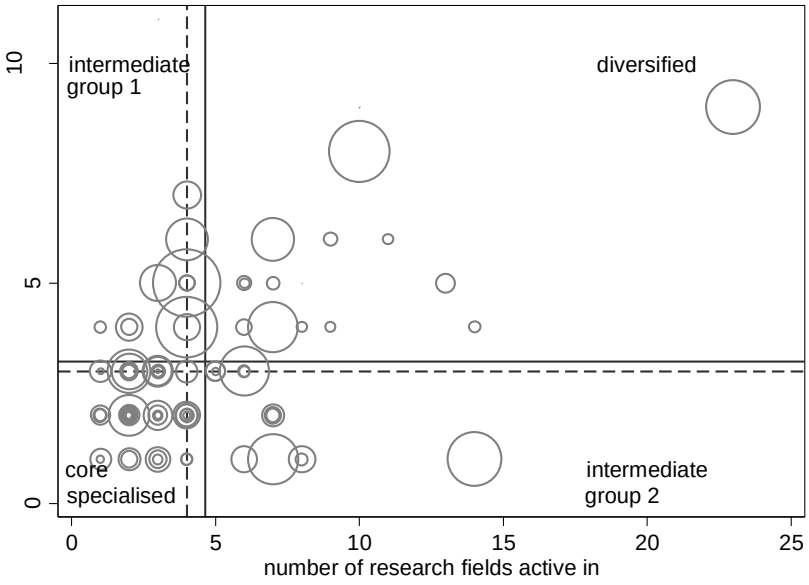

Figure 1 plots these two indicators against each other. Each circle is a firm and the width of the circles reflects the employment, in other words, size of the firm. The vertical axis measures the degree of market diversity and the horizontal axis measures the degree of

[7] 40 fields are grouped under 8 main categories. These categories are taken from the European Commission Cordis Work Program on ICT, 2011-2012. Details about the categories can be found at http://cordis.europa.eu/fp7/ict/programme/home_en.html

diversity in expertise in production. The solid and dashed line marks the mean and median values of both indicators respectively. Two groups emerge from Figure 1: the core-specialised small firms and the large diversified firms. Additionally there are two intermediate groups. Below we explain each category briefly. Further details regarding the differentiating characteristics of each group are presented in section 5.2.

- *Core specialised small firms*: Bulk of our sample belong to this group. These firms are relatively small in size. They focus on 2-3 core activities to produce few numbers of products and sell these products in a limited number of markets.
- *Intermediate group 1*: Firms in this group are larger in size. They focus on a limited number of core fields. However due to the wide applicability of the products, markets are diversified. For instance a firm that work on "trustworthy ICT" may produce only a number of products (or services) but since this area is applicable to most businesses this firm could easily serve to many markets at the same time. The original core competence concept developed in Prahalad and Hamel (1990) finds spirit in this intermediate group.
- *Diversified large firms*: These firms have expertise in many subfields, produce many products and services and for this reason operate in many sectors. Highly related product markets and size are among the explanations why firms diversify through internal development (e.g., Doving and Gooderham, 2008).
- *Intermediate group 2*: Firms in this group also have expertise in many subfields. Expertise in different areas are complementary and used to produce few (or many) products that are sold to one or two markets only. Firms that operate in the defense industry is a good example. These firms combine expertise in many fields to produce a range of products that are mostly sold to the defense sector.

The taxonomy explained briefly above is related to the idea of Vaona and Pianta (2008) where firms manage innovation according to two complementary strategies: (i) "technological competitiveness strategy" is build on product innovation through internal R&D efforts. The objective is opening up new markets, (ii) strategy of "active price competitiveness" is built on process innovation with the main aim of increasing efficiency and production flexibility. Our idea is also related to the research on company strategic orientation (O'Regan and Ghobadian, 2005; Laforet, 2008). Firms may choose to compete on the basis of new opportunities and products and respond quickly to changing external environment (prospector firm) or may compete on the basis of price and increase efficiency to keep market share (defender firm). We discuss the link between the ideas above and our taxonomy in section 5.

The main argument in this paper is that firms that differentiate along the diversity in production and markets have different strategies regarding the treatment of innovation. Specialised and diversified firms may be equally innovative. However how they manage R&D and innovation could be quite different. To be more precise we expect the organisation structure, sources of innovation, cooperation dynamics and funding of R&D to be different in each group.

5. Empirical Findings

5.1. Key indicators and innovation performance

This section compares core specialised, diversified and intermediate group firms on the basis of key indicators. It is important to state a few observations on the organisation of the firms before looking at how innovation is managed in these firms.

Table 1 presents the results of the comparison between four groups. The first column indicates the results of the two-sample t-test for mean differences as explained in the methodology section. We statistically compare two groups at a time and if the result returns a significant statistics in any of the two-sample comparisons we indicate it with an asterix. In this way we can easily see the variables to investigate in a more detailed manner. Table 1 shows that there are significant differences among firms regarding the organisation of the firm which can mostly be explained by size.

Core specialised firms are less innovative than other firms. Core specialised firms produce less number of innovative products and processes and less number of innovations with value added contributions compared to other firms. This finding supports earlier findings on the relation between size, R&D, and innovation. Cohen and Klepper (1996) for instance show that firms with larger size (measured as sales) invest more on R&D and produce more (process) innovations. Whereas Pavitt, Robson and Townsend (1987), Fritsch and Meschede (2001) and Shefer and Frenkel (2005) reach similar conclusions by using the number of employees as a proxy to size. When we look at the quality of innovation defined by share of the innovations with value added contributions in total number of innovations we found no statistically significant differences among groups of firms. In all groups about half of the innovations bring value added contributions. Core specialised firms are smaller in size and do not have seperate R&D and design departments. The employees are involved in almost all stages of innovative process from R&D to product development and even marketing.

Diversified firms on the other hand are relatively large. Large size gives certain advantages to these firms regarding access to knowledge and financing R&D. These

advantages mostly drive from economies of scale and scope (Henderson and Cockburn, 1996). Almost all firms have separate R&D and design units however this does not hold these firms back to diversify innovation inputs through R&D and design outsourcing. In this sense diversified firms use mixed strategy towards innovation inputs. The elements of R&D and design that are not crucial to firm are outsourced to third parties. Table 1 does not show any particular differences among two intermediate groups accept that firms that diversify on expertise produce more innovations compared to firms that diversify on markets. Intermediate group 1 firms specialise in few core activities and produce few products and services that are applicable to most sectors. In this sense we expect these firms to be more innovative than the intermediate group 2 firms. However our empirical findings contradict our expectation.

There are no differences among groups of firms regarding age, exporter status, employee training initiatives and outsourcing. All in all by looking at the overall picture in Table 1 we can safely argue that size, directly or indirectly, explains the key differences among groups.

Table 1: Comparing key firm indicators between groups

	t-test	Core specialised	Intermediate group 1	Diversified	Intermediate group 2
		Mean (st. dev)	Mean (st. dev)	Mean (st. dev)	Mean (st. dev)
no of innov. (1)	*	9.12 (11.41)	14.64 (11.47)	13.88 (12.54)	23.42 (55.91)
no of V.A. innov. (2)	*	3.70 (4.60)	3.45 (1.97)	9.29 (13.17)	10.62 (27.01)
quality innov. (2) / (1)		0.49 (0.29)	0.41 (0.29)	0.54 (0.29)	0.51 (0.24)
R&D department	*	0.57 (0.50)	0.83 (0.39)	0.82 (0.39)	0.79 (0.43)
R&D outsourcing	*	0.32 (0.47)	0.58 (0.51)	0.47 (0.51)	0.50 (0.52)
Design department	*	0.39 (0.49)	0.42 (0.51)	0.82 (0.39)	0.57 (0.51)
Design outsourcing	*	0.26 (0.44)	0.42 (0.51)	0.76 (0.44)	0.21 (0.43)
Employee training		0.79 (0.41)	0.75 (0.45)	0.82 (0.39)	0.79 (0.43)
Export		0.40 (0.50)	0.67 (0.49)	0.59 (0.51)	0.36 (0.50)
Outsource		0.15 (0.36)	0.25 (0.45)	0.29 (0.47)	0.29 (0.47)
Age		7.53 (5.28)	10.08 (7.08)	7.71 (6.58)	9.36 (9.46)
Employment	*	19.34 (21.53)	70.18 (80.08)	48.78 (67.96)	43.78 (54.01)

Note: All indicators are measured on a likert scale from 1 to 5, 1: not important, 5: very important. The four groups compared are described in section 3. The average of quality of innovation is calculated from the firm values. The t-test refers to two-sample mean comparison test as described in the methodology section. The asterix indicates that mean differences between any two groups are statistically significant at least at the 10 percent level.

5.2. Innovation strategies

In this section we compare the innovation strategies of firms in four groups as explained in section 3. We choose three sets of indicators that are vital for innovation. First set of indicators assesses the cooperation patterns of firms. As argued by many researchers cooperation among firms can be an important source of innovation (e.g., Lundvall, 1993;

Porter, 1998, Özkanlı and Akdeve, 2009). Innovation capabilities of firms depend on external processes such as new competencies and cooperation with other organizations as well as internal processes. Firms do not innovate in isolation (e.g., Nelson, 1993; Porter, 1998; Ritter and Gemünden, 2003). The second set of questions deals with the sources that firms benefit from to manage the innovation process. Size and sector may explain why firms use different sources for innovation. Large firms may benefit from internal R&D efforts, may have their own R&D and design department and may have easy access to knowledge and finance (Henderson and Cockburn, 1996). Since our sample consists of ICT firms the sector may only play role as a market. The third set is about the funding of R&D efforts. Existence of funding opportunities such as venture capital, government supports and R&D projects are vital for financing R&D (e.g., Lach, 2002; Almus and Czarnitzki, 2003; Blasco and Carod, 2008). However not all firms benefit from these sources in a homogeneous way. We expect that firms that differentiate along the diversity of production and markets have different innovation strategies and management style.

Table 2: Comparing innovation strategies between groups

	t-test	Core specialised	Intermediate group 1	Diversified	Intermediate group 2
		Mean (st. dev)	Mean (st. dev)	Mean (st. dev)	Mean (st. dev)
Cooperation					
share firm knowledge	*	2.13 (1.70)	3.17 (1.75)	3.53 (1.50)	2.29 (1.59)
R&D	*	2.15 (1.72)	3.67 (1.44)	3.41 (1.58)	3.21 (1.53)
design	*	1.96 (1.74)	2.92 (1.78)	2.94 (1.25)	2.93 (1.49)
new tech. development	*	2.09 (1.67)	3.08 (1.51)	3.41 (1.42)	3.14 (1.61)
production	*	1.68 (1.59)	2.58 (1.51)	1.53 (1.07)	2.57 (1.60)
new product development	*	1.83 (1.71)	3.75 (1.66)	3.24 (1.52)	2.86 (1.56)
marketing		1.66 (1.56)	2.50 (1.88)	2.00 (1.27)	2.43 (1.65)
education	*	1.38 (1.33)	3.00 (1.76)	2.65 (1.22)	2.36 (1.74)
funding of innovation	*	1.21 (1.28)	2.17 (1.64)	1.65 (1.46)	1.57 (1.02)
Sources of innovation					
firm R&D and design		4.28 (1.15)	4.33 (1.23)	4.24 (1.09)	3.93 (1.44)
other departments of the firm	*	3.11 (1.47)	3.92 (1.31)	2.76 (1.44)	3.00 (1.36)
other firms in the same group		1.70 (1.35)	1.75 (1.22)	2.00 (1.32)	1.50 (1.16)
suppliers and customers	*	3.96 (1.31)	3.92 (0.90)	4.00 (1.27)	3.21 (1.25)
R&D coop. with other firms		2.15 (1.32)	2.83 (1.53)	2.53 (1.66)	2.50 (1.40)
technical consultancy		2.00 (1.35)	2.42 (1.68)	1.94 (1.20)	2.43 (1.22)
patents	*	1.60 (1.14)	1.67 (1.07)	1.76 (1.35)	2.36 (1.22)
new products of other firms		2.60 (1.44)	3.00 (1.41)	2.12 (1.41)	2.93 (1.44)
Funding of innovation					
firm (or owner) funds		4.32 (1.14)	4.58 (0.79)	4.47 (1.01)	4.57 (1.09)
credits		2.07 (1.40)	1.80 (1.48)	1.82 (1.24)	2.64 (1.55)
family funds		1.58 (1.26)	1.50 (1.27)	1.47 (1.07)	1.79 (1.58)
partner funds		2.36 (1.62)	2.91 (1.87)	3.12 (1.90)	2.79 (1.76)
public R&D funds	*	2.78 (1.62)	4.10 (0.74)	3.00 (1.84)	3.62 (1.50)
foreign projects	*	1.21 (0.77)	2.10 (1.79)	1.94 (1.56)	1.64 (1.28)
business associations		1.19 (0.63)	1.30 (0.95)	1.35 (1.06)	1.07 (0.27)

Note: All indicators are measured on a likert scale from 1 to 5, 1: not important, 5: very important. The four groups compared are described in section 3. The t-test refers to two-sample mean comparison test as described in the methodology section. The asterix indicates that mean differences between any two groups are statistically significant at least at the 10 percent level.

Table 2 presents the results. We used a similar empirical strategy as described above and conduct group by group mean comparison test and indicate a statistically significant result with an asterix. A first look at the results we see that the most important distinctive feature is the cooperation patterns. Core specialised firms cooperate less compared to other firms. There are also some differences among firms regarding sources of innovation and funding of R&D. Below we investigate each group in a detailed way. Figure 2 summarizes the main characteristics of firms in each group.

Figure 2: Group characteristics in the specialisation vs. diversification taxonomy

Diversity in markets	FIRMS DIVERSIFY MARKETS • Cooperation distinctive innovation strategy • Horizontal cooperation (R&D and new product development) • Market watch and other consultancy services • Use many sources to acquire knowledge to be competitive in variety of markets • Obtain large scale R&D funding	DIVERSIFIED • Separate R&D, design and marketing departments • Cooperate both horizontally and vertically • Mixed innovation strategy. Use own sources and outsource non-core activities • Design outsourcing • Obtain large scale R&D funding
	CORE SPECIALISED FIRMS • Small software companies • Innovation without R&D • Benefit from own R&D and own funding • Firm specific knowledge is strategic • Vertical cooperation • small scale R&D funding	FIRMS DIVERSIFY PRODUCTION • cooperation is not a strategic asset. There is some form of vertical cooperation • complex products that needs expertise in several fields • rely on more formal sources of innovation such as patents • obtain technical consultancy • obtain large scale government R&D funding
	Diversity in production	

5.2.1 Core specialised firms

Firms in this group specialise on few subfields and research areas, produce few products and serve to limited number of markets. Small size is a distinctive characteristic that also explains the organisation and the management of innovation. In most core- specialised firms there are no seperate R&D and design units and even no specific job definitions within the company. About 50% of the firms in this group have 9 and less employees who are involved in all stages of innovation, production and marketing. Many core-specialised firms are small software producers. There are quite a number of cases that support the innovation without R&D argument (e.g., Som, 2012). For instance Arundel, Bordoy and Kanerva (2008) argue

that large number of innovators do not invest in R&D. Especially in high-tech industries this is more commonly observed (Srholec and Verspagen, 2012). Software firms develop an idea and produce a marketable product or provide solutions to other companies on a specific problem thus many do not have seperate R&D units or personnel and even may have no specific expenditures on R&D.

Core specialised firms cooperate less compared to other firms. Size determines the cooperation activities of firms. In almost all different cooperation activities except cooperation in marketing, core specialised firms significantly differ from the other groups. This difference is especially apparent in R&D cooperation and cooperation towards developing new products. It could be the case that core specific activities are vital for firm's survival and for this reason firms are hesitant to cooperate with other parties because firm specific knowledge is useful to competitors. Another explanation could be the structure of competition. Both core specialised firms and intermediate group 2 firms serve to few markets and in some cases only to one market (example, defense industry). In these cases cooperation may hinder competitive position of the firm as cooperation requires disclosure of firm specific knowledge.

We do not find significant differences between core specialised firms and other firms in terms of the sources used in the innovation process. Like all other firms core specialised firms benefit the most from own R&D and design efforts and cooperation with the suppliers and consumers. Core specialised firms cooperate vertically with suppliers and consumers rather than cooperating horizontally with other firms and research bodies. In an empirical research for China Zeng, Xie and Tam (2010) also reach a similar conclusion.

Core specialised firms use own funds for innovation. Only a number of firms benefit from R&D subsidies. Some firms use other sorts of indirect subsidies like R&D tax credits, free office space, use of university resources without any charges etc. Firms that use this sort of indirect subsidies are mostly located in incubators within technology parks.

5.2.2. Intermediate group 1

Firms in this group diversify markets but not production. They have expertise in few subfields but produce more products compared to the core-specialised group. The specific fields that firms build competence have wide applications. For instance, a firm that has expertise on software, virtualisation or trusthworthy internet could in principle sell its products and services to many different sectors. A differentiating element of firms in this group is the R&D outsourcing strategy, which may be as a result of serving to many markets. Product differentiation works through R&D outsourcing strategy. Firms focus on the production of a

specialised input (core activity in a subfield) and combine this with other inputs to produce different products to serve many markets. At first sight the description of this group of firms is consistent with similar definitions in the literature such as prospector firms (Laforet, 2008) and technological competitiveness strategy (Vaona and Pianta, 2008). Both of these definitions argue that some firms build their strategy on pro-active innovation to serve many markets. Intermediate group 1 firms fit well to these descriptions except that the number of new products is not high compared to other groups (see Table 1).

Serving to many markets also plays role in the cooperation behaviour of the firms. Firms may need to cooperate with a wide range of suppliers and consumers to make the product more applicable to specific markets. For instance firm X that focus on trustworthy ICT, computing systems and preservation of digital libraries serve 10 different markets that include ICT, health, engineering and education. To develop the products in such a way to satisfy consumer needs firm X may have to cooperate with other parties. We see from Table 2 that cooperation on R&D, new product development and employee training is high compared to all other groups. Cooperation is a distinctive strategy to manage the innovation process.

Diversifying on the market explains some important differences regarding the sources of innovation as well. Different from the other groups, firms in this group benefit from R&D cooperation, technical consultancy and a detailed market watch. As emphasized above firms that serve many markets may need sector specific information regarding competitors and products. This may require cooperative efforts and an outsourcing strategy that is based on acquiring knowledge and expertise to be competitive in a variety of markets.

As regards to funding of R&D and innovation firms in this group benefit from R&D subsidies, joint projects and other government funds which is another distinctive feature of intermediate group 1. The existence of relatively larger firms in this group may explain this funding pattern (i.e., raising R&D funds through joint projects and government funds).

5.2.3. Diversified firms

These firms diversify both production and markets. Expertise in various fields are combined to produce a variety of product that could be sold in a variety of markets. Diversified firms are relatively larger but not as large as intermediate group 1 firms. Because of diversification on both production and markets these firms have mixed innovation strategy based on costs. Firms have separate design and R&D units and even separate marketing departments. R&D is strategic but outsourcing of design activities is common as well. In fact design outsourcing is a feature of firms that diversify markets. Design is not viewed to be as strategic as R&D, thus firms that serve to many markets could easily outsource this activity to third parties.

Diversified firms cooperate more. These firms use both static cooperation in the form of knowledge transfer and dynamic cooperation in the form collective learning (Tödtling, Grillitsch and Höghlinger, 2012). Cooperation is high in almost all categories except cooperation in production. Size also matters here. Production can easily be handled within the firm, which may explain why firms do not cooperate in production. Firm R&D, design and relations with suppliers and consumers are the most important sources of innovation. Different from other groups, cooperation with other partner firms is important. Some firms in this group belong to a large holding company, which may explain why cooperation with partner firms (or the holding company) is important. Compared to the firms in intermediate group 1 diversified firms cooperate more only in terms of sharing knowledge and new product development. In general terms cooperation increases with diversification in production and markets but diversified firms are mostly less cooperative compared to intermediate group 1 firms. This suggests that there could be an inverted U-shape relation between specialization and cooperation. For instance, Cantner and Graf (2004) show that in German technology regions cooperation is highest for an intermediate degree of specialization. Our results show evidence supporting earlier findings.

R&D subsidies, funding through (joint) R&D projects as well as company funds are important sources of funding. Firms have special personnel or sometimes even a department to deal with the administrative steps in applying to R&D subsidies and projects. It is also common that firms purchases expertise when applying to R&D projects especially the ones that are funded by foreign sources such as EU framework projects.

5.2.4. Intermediate group 2

Firms in this group combine expertise in many technological fields to serve to few markets. The reason for this could be that these firms produce complex products that need expertise in many different areas. Firms that operate in the energy and defense sector constitute good examples. Production in these sectors needs expertise in a variety of technological fields but the product may be quite specific and sold to only a number of sectors.

From Table 2 we see that cooperation is not a strategic asset for innovation. Firms do cooperate but they are somewhere in between core-specialised firms and the remaining two groups that firms are relatively large (diversified firms and intermediate group 1). It is interesting to observe that intermediate group 2 firms resemble to core specialised firms in cooperation. The reason for this could be that firms in both groups serve to few markets. Within market competition is fierce which might explain why firms in both groups are hesitant to share firm specific knowledge and expertise, thus cooperate. Recent research by

Faria, Lima and Santos (2010) show that decision to cooperate and who to cooperate are different choices and their determinants are different from each other. In the case of firms that serve to limited number of markets firms choose to cooperate less with all parties.

Different from the other groups the knowledge stock (patents) is an important source of innovation. The reason for this could be that firms in this group merge expertise in different sub-fields and produce complex products. Complexity in production may require complex knowledge that could be obtained from patents. This may also explain why firms need technical consultancy from third parties. In the innovation process technical knowledge seems to be much more important than customer feedback.

Like in other groups firms' own funds are an important source of funding of R&D and innovation. Besides this part of the innovative projects are funded by government institutions such as TUBITAK (The Scientific and Technological Research Council of Turkey).

5.3. Firm cases

In the previous section we discussed the group specific characteristics of innovation management. In this section we look at firm cases that provide further information on the innovation strategies and other factors such as networking and labour market. For our purposes we selected four firms that reflect the basic characteristics of the taxonomy described in section 4. Strengths and weaknesses in competitive position for each firm case is summarised in Figure 3.

5.3.1. Core-specialised case

Firm A is a typical example of inward looking firm both in terms of knowledge and financial sourcing. It conducts R&D and design activities internally. Based on the RBV approach, the firm may have capabilities that are developed within the firm and are difficult to imitiate (Peteraf, 1993; Barney, 2001). The firm may gain competitive advantage if these capabilities remain firm specific. On the other hand lack of separate R&D/design department might hinder the returns to internal capabilities of the firm. In none of the activities investigated Firm A has cooperative links to other firms and organisations Firm A outsources part of its activities, which may turn in to cooperative type of relation in the future. These points support earlier findings in section 5.2.1 that core-specialised firms cooperate vertically and avoid cooperations that may cause firm specific knowledge to diffuse.

As for the firm organisation, there are some factors to pin point such as firm size and human capital. Although, large organizations are much experienced in the standardization of procedures, in the ICT sector where project based tasks are dominant, being small could bring

the advantage of flat-type organization that encourages peers to communicate directly. Firm A relies mostly on the local labour market. However, this is not a sustainable strategy especially in the ICT sector where labour mobility is high (e.g., Power and Lundmark, 2004).

For Firm A the most drastic threat is lock-in which commonly refers to dependency on certain products, services, or environmental conditions. Kogut and Zander (1982) argue that early history of cooperation tends to lock-in subsequent cooperation, therefore, information is constrained in certain locations and firms only take the signals of the neighbours into consideration. This is especially stronger in our case where most small firms are clustered in incubators and technology parks. In such a case, the diversity in cooperative ties is necessary to avoid lock-in and path dependency (Grabher, 1993).

As for the Firm A searching alternative sourcing mechanisms outside the local could be a strategy for survival and further development. Firm A may choose to be a part of a regional network in order to reduce uncertainty, increase the quantity and the quality of information and avoid lock-in situations.

5.3.2. Intermediate group 1 case

Firm B follows a different strategy in terms of sourcing innovation. Firm B specifically cooperates with other actors to gain new knowledge and expertise for design activities and new product development. But perhaps because cooperation activities are not diversified these efforts do not turn in to innovative outcomes. In section 5.2.2 we mentioned that cooperation is a distinguishing innovation strategy for firms that diversify markets but it seems that the specific aim and the narrowness of cooperation do not result in expected outcomes.

As for the funding of innovation, Firm B mostly uses internal funding and project incentives for innovation. However, there is no emphasis on alternative sourcing such as participating in EU projects.

Firm B is a medium size firm of which half of the employees have bachelor degree. Employees have specific job definitions and they work in different departments within the firm. Like Firm A, Firm B also relies on the local labour market. Given that the firm is relatively larger Firm B may face a mismatch between demand and supply. To cope with high labour mobility in the ICT sector and to access a pool of qualified personnel Firm B could benefit from networking. Although there are some cooperation activities on design and new product development, Firm B does not fully exploit the network benefits (e.g., access diverse information and capabilities).

The most probable threat is the limited local labour pool. It is true that the research triangle in Ankara produces about 500 to 600 skilled engineers every year that could work in

the ICT sector. But the fact that there are about 550 high-tech firms only in the three technology parks may create a supply shortage. Besides it is better to diversify in terms of employment as well. ICT occupations are not tied to geography and some routine tasks could be completed over distance. Outsourcing non-strategic work could well reduce costs and enhance the efficiency of the firm.

As Granovetter (1973) suggests the benefits of networking are not limited to the strength of the collaborators but their established links. As such, Firm B can exploit collaborators' ties especially the ones that operate in Istanbul. These weak ties are important to diversify the labour pool. Morover since Firm B serves to many markets taking full advantage of cooperation is important in mantaining the diversity in markets.

5.3.3. Diversified firm case

Firm C is a relatively large firm with about 100 employees. It has separate R&D, design and marketing units. The company is organised in such a way that each department supports the innovative process. In terms of cooperation Firm C behaves differently from the other firms we investigated in the previous sections. Firm C cooperates on R&D, technology improvement, new product development and personnel training. On the other hand, the firm is open to use knowledge-based organizations for any type of the activities. Thus Firm C diversifies cooperation activities and in this way differentiates from Firm B. Cooperation is built on trust between parties indicating the social complexity of the firm (Barney, 1999). According to this view, reputation among customers and suppliers, firm's culture, and its trustworthiness are the strategic assets of socially complex firms.

While cooperation with other actors is emphasized in the process of innovation, Firm C relies on internal sources in the production process. Despite some tendency, outsourcing and cooperation in production are not deemed to be strategies that can be used to decrease the production costs. Perhaps because of the reason that firm diversifies on the grounds of both production and markets firm sources labour from a diversified pool. Openness to inter and intraregional labour supply is crucial, but the firm has difficulty in finding skilled labour. This is a common problem in the high-tech sectors in Turkey. Most firms complain that they could not find skilled workers specific to firm needs. We still think that firms should fully exploit the benefits of networking and moreover try other ways such as international outsourcing to reach a diverse labour pool.

Firm C exploits various types of financial resources therefore internal funding is not burdened by "risky activities". Other sources such as public incentives or EU projects stay as alternative sources. As we have argued in previous sections size is an important determinant

of obtaining large scale funding. Larger firms may employ full-time or part-time personnel to deal with the bureaucratic steps involved in R&D funding applications. There are even cases that these services are outsourced from third parties.

We think that the real challenge for Firm C is to find the right strategy mix to maintain diversity on both grounds. Building expertise in many fields and serving to many markets is a not an easy task. Some firms that diversify production and markets are part of a group or a holding company. This creates a more secure environment for diversified firms to maintain competitiveness. Thus maintaining competitiveness is a threat for diversified firms. One way to handle this is to cooperate with diversified firms that also try to cope with similar challenges. As Tether (2002) argues common challenges may force firms to cooperate. Through cooperation diversified firms may create a secure environment that may sustain their competitive positions.

5.3.4. Intermediate group 2 case

In the ICT sector cooperation with competitors, university-industry linkages as well as user-producer links play crucial role in the development and adoption of flexible technologies (Santangelo, 2001). Firm D involves in vertical cooperative relations. Both cooperation partners and knowledge-based organizations are used to access knowledge and know-how in various fields that this firm built expertise on. On the other hand, less emphasis on cooperation with competitors stands out as the main weaknesses. However as we have discussed in section 5.2.4 this could be because that the firm sells its products to limited number of sectors and within sector competition may hinder Firm D to cooperate with competitors.

Patenting activity is crucial in terms of securing property rights of strategic sources in the ICT sector. Our detailed investigation revealed that Firm D does not rely on patents to obtain appropriate returns of its R&D efforts (Hall and Ziedonis, 2001). This could be because that patenting activity is generally low in Turkey or it might be as a result of sector specificity. Most of the firms in this group conduct R&D on energy and defense sector. Especially in the defense sector firms generally rely on secrecy rather than patents to secure property rights.

Firm D is a medium sized, relatively old firm that has quite extensive exporting activity. The sources of R&D, new product development and human capital policy are strongly affected from the fact that this firm has expertise in many related fields. In the first place the firm uses many different sources to support innovation. Through vertical cooperation, obtaining technical consultancy and patents the firm tries to maintain knowledge in variety of

fields. Diversity in production brings diversity in the employee structure. Firm D searches different locations to find skilled personnel that match its variety of competences.

Figure 3: Overview of firm cases

Specialised firms: Firm A		
	Strengths	**Weaknesses**
C		low cooperation
SI	conducting R&D/design activities internally	reluctance to use external R&D sources
FI	internal funding	obtain large scale funding
FO	flexibility outsourcing activity	small firm; no exporting activity relying on local labour market no separate R&D department or budget
Intermediate group 1 (diversify markets): Firm B		
	Strengths	**Weaknesses**
C	sharing knowledge and expertise cooperation on design and new product	less emphasis on collaborator's network
SI	relying on internal R&D and design units	cooperation on design does not turn into innovative outcomes moderate efforts on patenting and applying technical consultancy
FI	internal funding & project incentives	international sourcing
FO	medium size; exporter presence of educated personnel	relying on local labour market
Diversified: Firm C		
	Strengths	**Weaknesses**
C	cooperation on R&D, technology and new product development with all actors cooperation is based on trust, expertise and strategic partnership	no use of knowledge based organizations
SI	separate R&D, design and marketing departments	
FI	internal funding, public incentive and EU projects	
FO	tendency to outsource; medium size; exporter openness to diverse labour markets	no outsourcing activity difficulty in finding skilled labour
Intermediate group 2 (diversify production): Firm D		
	Strengths	**Weaknesses**
C	cooperation on R&D and technology but with suppliers and consumers (vertical ooperation) using knowledge based organizations for R&D, design, technology and product development; technical consultancy	less emphasis on cooperation with competitors
SI	use of various sources	patenting activity is not common
FI	internal funding and EU projects large-scale government funding	

FO	medium size with exporter status no difficulty in finding skilled personnel outsourcing activity	

C: Cooperation, SI: Sources of Innovation, FI: Funding of Innovation, FO: Firm Organisation

Beyond its expertise in ICT, Firm D operates in a strategic sector. Turkish government recently announced that energy, defense and automotive industry as high priority sectors. This is a major opportunity for Firm D because it is expected that these sectors will grow in great extent in the next decade. If Firm D succesfully follows emerging technologies in the industry and builds compatible internal capabilities it can maintain a sustainable growth path. Another advantage of doing business in a high priority sector is the extensive funding opportunities. Firm innovation activities are mainly financed by different sources such as internal funding and EU projects. However large-scale government R&D funding is an opportunity that could be exploited by firm D.

6. Conclusion

In this paper we analyse innovation management strategies of ICT firms in Ankara using a novel taxonomy of firms. We place firms on a specialisation-diversification spectrum based on expertise and markets. Firms can specialise in few technology fields or alternatively can build expertise in many related fields. In a similar way firms can serve to few or many markets. The literature in RBV, dynamic capabilities and core competency constitute a playground where this novel taxonomy is build on.

We argue that the way that firms manage innovation is affected from the position of firms in the specialisation-diversification spectrum. To empirically test this argument we conducted face-to-face interviews with the managers of ICT firms in Ankara. As a part of the questionnaire we collected detailed data on firms' expertise and the markets that they serve. This information is then used to form the taxonomy of firms that is based on specialisation and diversification in production and/or markets.

The taxonomy shows that almost half of the firms in our sample are, what we call, core-specialised firms that specialise in few technology fields and markets. These firms mostly rely on own funding, R&D and expertise to manage the innovation process and cooperate less with suppliers, customers and other actors because of the fear that firm specific knowledge can be copied and used by competitors. On the other hand we have relatively large corporate firms that both diversify production and markets. These firms determine the needs in the innovation

process and act accordingly. Diversified firms cooperate more with other actors, may outsource non-core activities and may even share strategic information with other firms to improve products. The taxonomy clearly differentiates between these two groups.

There are two additional groups of firms, which we label as intermediate groups 1 and 2. Our analyses show that the distinctive element of firms that specialise in few fields but sell to many markets (intermediate group 1) is the versatility of capability in the core technological field (i.e., some fields such as trustworthy ICT has applications in many markets). However this capability should be merged with inputs and expertise so that the product becomes adaptable to many markets. This requires an (R&D) outsourcing strategy combined with enhanced cooperation based on trust. In the case of firms that diversify production but not markets innovation management relies on integrating many related expertise in to complex products that are mostly sold to one sector. Firms that operate in the defence and energy sector mostly fall in to this category. Contrary to intermediate group 1, cooperation is not a vital strategy for innovation. It may even hinder innovation because within market competition is high and if firm specific knowledge leaks competitors may easily adapt and use this knowledge. Intermediate group 2 firms use strategies that help them to integrate expertise such as specific knowledge in patents or technical consultancy.

The analyses result in two important observations. First is that size matters. Most differences among firms are explained by size. Small firms cooperate less and mostly use internal sources to fund R&D and manage the innovation process. As the firm cases show this may even result in a lock-in situation where small size hinders the growth of the firm. Face-to-face interviews show that firms do have a strategy to survive but most firms do not have escape strategies to break the lock-in situation. As such it seems that a great number of core-specialised firms will remain small even if they survive. We propose policy makers to design policy tools that may act as escape strategies for small core specialised firms. Forcing firms to cooperate or setting up a regional knowledge management system to enhance regional spillovers are examples to such policies.

The second observation is related to cooperation. ICT Firms in Turkey cooperate less compared to its European counterparts. The problems in networking is well recognized in Turkey. For instance, one of the three key recommendations in a foresight of Ankara University Science Park was to build a deliberate networking strategy (Fikirkoca and Saritas, 2012). This, however, we think is mostly a cultural issue. Firms are hesitant to share information with other actors because of the fear that firm specific knowledge may be copied and adapted by competitors. We think that this is a main weakness of ICT firms in Turkey

which needs action at the macro and institutional level. We propose policy actions such as setting up an education curriculum that is build on cooperation and team-working skills or setting up a binding and efficiently working judiciary. Needles to say these efforts may become effective only in the long run.

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Appendix

Table A.1: Descriptive statistics

	Mean	Std. Dev.
number of innovations (1)	12.93	23.81
number of value added innovations (2)	5.72	12.51
quality of innovations (2) / (1)	0.49	0.28
R&D department (dummy)	0.69	0.47
R&D outsourcing (dummy)	0.41	0.49
Design department (dummy)	0.51	0.50
Design outsourcing (dummy)	0.37	0.49
ever outsourced? (dummy)	0.21	0.41
Employee training (dummy)	0.79	0.41
Exporter status (dummy)	0.47	0.50
Age	8.19	6.51
employment	34.62	49.98
cooperation: importance of		
sharing firm knowledge	2.56	1.73
R&D	2.76	1.73
design	2.42	1.68
new technology development	2.63	1.67
production	1.91	1.53
new product development	2.51	1.79
marketing	1.96	1.59
education	1.99	1.56
funding of innovation	1.48	1.35
Sources of innovation: importance of		
firm R&D and design	4.22	1.18
other firm departments	3.14	1.44
other firms in the same group	1.73	1.29
suppliers and customers	3.84	1.26
R&D cooperation with other firms	2.37	1.43
technical consultancy	2.11	1.34
patents	1.77	1.19
new products of other firms	2.61	1.43
Funding of innovation: importance of		
firm (or owner) funds	4.42	1.06
credits	2.08	1.41
family funds	1.58	1.26
partner funds	2.65	1.73
public R&D funds	3.11	1.62
foreign projects	1.54	1.23
business associations	1.21	0.73

Note: N: 90. Cooperation, sources of innovation and funding of innovation are measure on a likert scale 1: not important at all, 5: very important. Dummy variables are indicated in paranthesis. The remaining variables are continous