GENDERING SCIENCE, TECHNOLOGY AND INNOVATION: THE CASE OF R&D IN TURKEY

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ABSTRACT

Research and development (R&D) involves innovative studies conducted systematically to increase knowledge and practices (Keleş, 2007: 45). While Turkey's R&D intensity score is below the European average, it has increased continuously since the 2000s. Meanwhile, development of human capital in R&D has become one of the aims of Turkey's National Strategy of Science, Technology and Innovation.

This paper will focus on the gendered dynamics of careers in R&D, a field with a wide gender gap, through interviews conducted with employees in a university technopark and some of Turkey's large R&D centers to explore the relationships between science, technology, innovation and gender.

Keywords: *R&D, Gender, Science, Innovation, Technology, Turkey.*

ÖZET

BİLİMİ, TEKNOLOJİYİ VE İNOVASYONU CİNSİYETLENDİRMEK: TÜRKİYE'DE AR-GE ÖRNEĞİ

Araştırma-Geliştirme (Ar-Ge), bilgi birikimini ve uygulamalarını artırmak amacıyla sistematik olarak yürütülen yenilikçi çalışmaları ifade eder (Keleş, 2007: 45). Ar-Ge yoğunluğu Türkiye'de AB ortalamasının epey gerisinde seyretmekle birlikte, 2000'li yıllardan itibaren sürekli bir artış trendi göstermiştir. Ar-ge insan kaynağının geliştirilmesi de Ulusal Bilim, Teknoloji ve Yenilik Stratejisinin temel hedeflerinden biridir.

Bu makale, bir üniversite teknoparkının ve Türkiye'nin büyük AR-GE merkezlerinin çalışanlarıyla yapılan görüşmeler aracılığıyla geniş toplumsal cinsiyet uçurumlarının olduğu kabul edilen AR-GE alanındaki kariyer deneyimlerini toplumsal cinsiyet açısından inceleyerek bilim, teknoloji, inovasyon ve toplumsal cinsiyet arasındaki ilişkilere bakmayı hedefliyor.

Anahtar Kelimeler: *AR-GE, Toplumsal cinsiyet, Bilim, İnovasyon, Teknoloji, Türkiye.*

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Introduction

Research and development (R&D) involves innovative studies conducted systematically to increase knowledge and practices (Keleş, 2007: 45). In the long run, R&D is an essential factor for increasing wealth and efficiency (Jones & Williams, 2000). R&D intensity, the percentage of money spent for R&D and R&D human capital are each considered to be basic measures of progress in this field. While Turkey's R&D intensity of 0.84% is quite far below the EU's average intensity score of 1.97%, it has increased continuously since the 2000s. Meanwhile, development of human capital in R&D has become one of the basic aims of Turkey's National Strategy of Science, Technology and Innovation, and National Innovation System 2023.

R&D is considered a field with a wide gender gap. A similar pattern of vertical gender differentiation in the academy can be observed in related scientific activities in the private sector. In the private sector, however, the gender gap is wider, with the percentage of female researchers in the universities (41%) decreasing to 24% in the private sector (Meulders & O'Dorchai, 2013; 31-33). Though half of undergraduates and graduates are female in Turkey, there is a widening gender gap in terms of employment in R&D (Meulders & O'Dorchai, 2013; 44). Given this background, this paper[1] will focus on the gendered dynamics of careers in R&D through interviews conducted with 25 female and 25 male employees working in a university technopark, and in some of Turkey's large R&D centers in several sectors, such as electronics and automotives. Focusing on some aspects of gender differences in terms of career experiences in R&D and innovation, it explores the relationships between science, technology, innovation and gender.

Focusing on the gendered dimensions of career experiences such as curricular decisions in science, technology and engineering fields, role models and employment patterns, this paper explores gender segregation in Turkey's R&D sector.

Gendering Science, Technology and Innovation

Scholars have pointed out that the very definition of the knowledge society

[1] This paper is based on a project funded by TÜBİTAK (The Scientific and Technological Research Council of Turkey).

is gendered (Walby, 2011), as it often revolves around technology that traditionally has been dominated by men and discourses of masculinity (Wajcman, 1991). Cockburn (1985) sees masculinity as central in the definition of technology and technological competition and notes the conflation of technology and machinery with masculinity and domination. Besides the gendered constructions of science and technology, horizontal gender segregation is also seen across various scientific disciplines. Schiebinger (1989), for instance argues that in natural sciences women have been guided to fields such as biology or botany which are seen to fit traditional assumptions regarding femininity, while Keller (1983) points out the exclusion of women from other fields such as physics. Horizontal segregation in science therefore requires a detailed analysis based on scientific fields and economic sectors.

In the fields of science, technology, engineering and mathematics (*Science, Technology, Engineering and Mathematics-STEM*) in Western Europe and North America, there is a vast empirical and theoretical literature on gender relations and career experiences (Sonnert and Holton, 1995; Evetts, 1997; 1998; Eisenhart and Finkel, 1998; Hersch, 2000; Byko, 2005; Etzkowitz and Kemelgor, 2001; Huyer and Westholm, 2007). In this literature, vertical segregation is explored via the concept of the "glass ceiling" regarding the obstacles women face gaining access to decision-making processes in both the private and public sectors, and also access to income, prestige, job security, etc. It is complemented by the concept of the "sticky floor", denoting the dynamics that keep women "stuck" in the lower echelons of organizational hierarchies (Maron & Meulders, 2008, in Meulders & O'Dorchai, 2013; 86). That is, while the glass ceiling focuses on gender gaps in the higher echelons, the sticky floor explores widening gender gaps at the lower levels. Another analogy used to explore the participation of female researchers in commercial activities is that of the leaky "gender pipeline", which represents how the ratio of women falls as a scientific field's commercialization increases. The concept has also been adopted in studies on women and entrepreneurship, using the concept of the "leadership pipeline."

R&D is considered to have a wide gender gap. Various studies have focused on both empirical and theoretical aspects of gender in innovation, research and development in Western Europe and North America (Keller, 1992; Kirkup and Keller, 1992; Wynarczyk and Marlow, 2010; Wynarczyk, 2010). These studies show that the number of women in this field is small, and that female survivors in the field have either similar or higher performance levels than their male counterparts (Whittington & Smith-Doerr, 2005; 366). They underline the need to explore the structural and institutional dynamics of the filtering processes in the field of innovation. The role of women in society and certain cultural issues, such as early marriage, the gender employment gap and violence against women, and several indicators of the general economic, social and family environment affecting women all significantly reduce women's involvement in innovative activity (Carrasco, 2014).

The literature on gender and innovation also reveals the need to critically explore established definitions of innovation that favor men and spheres of industry and production dominated by men, as well as the need to enlarge the understanding of innovation in order to include both women and spheres dominated by women (Ljunggren *et al.*, 2010; Marlow & McAdam, 2012; Treanor & Henry, 2010).

In terms of policy making, scholars distinguish between three approaches taken over the past three decades (Schiebinger, 1999; 2008): the first focuses on programs designed to increase women's participation; the second seeks to increase women's participation by transforming research institutions; the third focuses on overcoming gender bias in science and technology by designing gender analysis into all phases of basic and applied research, from setting priorities to funding decisions, from establishing project objectives and methodologies to transferring ideas to markets (Schiebinger & Schraudner, 2011:155).

In line with policy making approaches, the various research paths and questions that can be pursued in the field of gender and innovation focus first on gender differences and similarities in innovation, secondly on gendered constructions of innovation, and finally on gendering processes of innovation (Müller et al. , 2011.) This paper explores gender differences and similarities in careers in R&D and innovation.

Studies on gender and STEM fields are based either on macro-cultural theories of gender segregation or micro-level studies with psychological models that emphasize the role of self-perceptions and role models. However, it is also critical to link the two levels in line with gender perspectives. This paper therefore focuses on gender differences and similarities in career experiences in the field of R&D in Turkey.

R&D and Women in R&D in Turkey

In contrast to the tendency in Western academia, where natural sciences are generally male-dominated fields, in Turkey, these fields have the most female academicians (Köker, 1988). With the establishment of the new nation-state in place of the Ottoman Empire, the “woman question” was considered by many actors during the modernization processes, being regarded as intertwined with the project of modernization and educational reforms. The ideals of the new regime pertaining to modern women were symbolized in the universities that were considered as visible representations of modernization and westernization. Hence, universities in Turkey developed as part of the modernization processes with an emphasis on the importance of education for women.

Various studies have focused on the employment of women in academia in Turkey (Öncü, 1979; Köker, 1988; Acar, 1991; 1993; Günlük-Şenesen, 1996; Özkanlı and Korkmaz, 2000; Özkanlı and White, 2009; White and Özkanlı, 2010; Healy, Özbilgin and Aliefendioğlu, 2005; Özbilgin and Healy 2004; Sağlamer et al. 2013) and the career experiences of women working in engineering (Tantekin-Ersolmaz et al., 2006; Özkale, Kuşku and Özbilgin, 2005; Zengin-Arslan, 2002; Smith and Dengiz, 2010; Kuşku, Özbilgin and Özkale, 2007.)

Though the development of human capital in R&D has been one of the basic aims of National Strategy of Science, Technology and Innovation, and National Innovation System 2023 of Turkey, there are few studies on gender dynamics in research in the private sector. One of the indicators of gender asymmetry in R&D is the relationship between R&D intensity - the proportion of R&D expenditure in GNP - and the proportion of female researchers. the European Commission’s report, She Figures 2012, on gender dynamics in research and innovation found that countries with low R&D intensity had the most female researchers in R&D while countries with high R&D intensity had the fewest female researchers in R&D (Meulders and O’Dorchai, 2013; 122). Likewise, Turkey has a relatively low R&D intensity but many female researchers in R&D. While R&D intensity in Turkey at 0.84% is quite a lot lower than that of European countries (1.97%), it has increased since 1996, with Turkey being fourth in Europe in terms of increase in R&D expenditures (European Commission, 2012). Given this rise in R&D intensity and Turkey’s national goals to improve human resources in R&D, it is critical to include a gender equality perspective in the policy making process.

Proportion of Female Researchers by Economic Activity (NACE Rev. 2) in the Business Enterprise Sector (BES) in Turkey and EU, 2009

	Manu factu ring	Manufacture of chemicals, chemical products	Manufacture of basic pharmaceutical products and pharmaceutical preparations	Services of the business economy	Oth er
Turkey	22.6	44.3	63.8	24.9	22.9
EU	14.6	26.9	45.4	19.3	26.2

Source: She Figures 2012, p. 74.

Proportion of Female Researchers by Sector in Turkey in 2009

	Higher Education Sector	Government Sector	Private Sector
Proportion of Female Researchers (%)	41	29	24

Source: She Figures, pp. 31-33.

Another aspect of gender asymmetry in R&D concerns the sectoral distribution of female researchers. In the EU, the private sector, which has the largest R&D budgets, has the fewest female researchers at 19%. However, the distribution of female researchers by sector in Turkey differs from the European pattern, in that the public sector has the highest R&D spending levels in Turkey yet the proportion of female researchers in the public sector is higher than that of female researchers in the private sector. On the other hand, higher education has the lowest spending in R&D but the proportion of female researchers is the highest. In R&D in the private sector the proportion of female researchers has declined since the 2000s despite the continuous increase in the number of researchers: while the proportion of female researchers was 26% in 2000, it fell to 23.5% in 2012 (European Commission 2007: 81). These dynamics underline the need to scrutinize the developments in science and technology in Turkey from a gender perspective.

Research Methodology

This article is based on interviews conducted for a larger mixed methods research project, “Career Paths and Gender in R&D and Innovation”. The research project focused on gender differences in the career experiences in R&D and innovation, with a focus on entrance to the innovation sector, career ladders, career interruptions and strategies, mobility, participation in projects, patent applications and acquisitions, and home-work balance. One university technopark (officially known as a Technology Development Region[2]) and three of Turkey's largest private R&D centers were chosen as the field of our research. In-depth interviews were conducted with 25 female and 25 male R&D employees working in the R&D centers and technopark firms.

Curricular Decisions

Women are less likely than men to enter science, technology, engineering, and mathematics (STEM) fields (Hill, Corbett, & St. Rose, 2010). Male-dominated fields can be unwelcoming to women on two dimensions: the first concerns the extent to which there are more men than women in a field. A disproportionate gender ratio can activate negative stereotypes about women's abilities (Cheryan et al., 2011). Although there have been increases in the number of women joining the engineering profession over the last two decades, women engineers are still in a minority in all countries (Hersh, 2000). The second unwelcoming dimension of male-dominated fields that is is the extent to which the field is assumed to embody stereotypes that are incompatible with female gender roles (Cheryan et al., 2009; 2011). Thus, Maskell-Pretz and Hopkins (1997) point to deep-seated gender barriers, rather than male domination, as the main reason for the current situation.

As mentioned earlier, the proportion of female STEM students, professionals and academics is higher in Turkey than in most European and other industrialized countries. For instance, even in manufacturing, the private sector female researcher ratio is 22.6% in Turkey compared to the EU average of 14.6%. Although all these percentages are more equal than most industrialized countries, the Turkish case has some particular characteristics in terms of gender regimes. The current study found that approximately 13-15% of researchers were female in automotive sector R&D centers, 22% in consumer durables manufacturing sector R&D centers and 30% in the university technopark.[3]

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[2] Several Technology Development Regions have been established since 2001 under the guidance of Development Plans (Technology Development Regions Law, No. 4691, 26,6.2001).

[3] Although the female employee ratio of the university technopark includes only R&D employees, from our interview data it was obvious that not all R&D employees were doing R&D jobs or tasks in technopark firms. In order to compare this women's ratio, a clear picture of the participation of women in technology development regions may be drawn from the number of female entrepreneurs

As far as women's occupational choices are concerned, those males and females from an individual's family or social environment who work in the fields of engineering, mathematics and science are critical role models. Especially those figures who are educated or are working in these fields caused women to significantly change their perceptions of these fields at an early age: these include "the parents who are both physics teachers," "the friend who entered a computer engineering program in university with a high score in the university entrance exams," "growing up in a world of engineering" or having "a relative doing lab experiments". It is also widely accepted that female role models are more effective than male role models in inspiring girls and women to enter STEM fields (Cheryan et al., 2011).

In terms of male researchers' occupational choices, engineer fathers, brothers and other men in the social environment were role models. These were reported as being more critical by women in developing their scientific curiosity. For instance, Ceren[4] explains her interest in science with reference to her physics teacher parents:

> "My mother and father are physics teachers. Even at breakfast we talk about parallel universes, quantum physics; we make fun of it. This is because they are physicists, and I still read physics. The fact that they were buying the magazine Science Technic and that I read it made me have an interest in astronomy. At the age of 12, I told them that I was going to buy a telescope and I did. My family started scheduling their holidays according to solar eclipses. We went to Bartın for the solar eclipse of 1999. There is a space camp in İzmir; I told them to take me there and they did. This all happened with their support. They could have said "no", they could have regarded a telescope as unnecessary."(Ceren, 27 years old, Computer Engineer, Software Developer, ICT firm in University Technopark)

The literature, however, emphasizes that stereotypical role models, regardless of the role model's gender, "may evoke in other women feelings of dissimilarity and create contradictory self-views, despite their shared gender (Cheryan et al., 2011), although this applies to women who have not yet chosen the domain. For women who have already chosen the domain or are otherwise highly

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in technoparks. However, it was impossible to obtain this ratio in these regions through officially available data. Evidence shows that the number of female entrepreneurs compared to male entrepreneurs in Turkey is markedly low. The share of female entrepreneurs is only 14%. The share of female entrepreneurs represents only 13.1% of the female workforce compared to 35.4% for men (Ozar, 2003).

[4] All the names are pseudo-names.

identified with it, female role models improve their attitudes toward STEM (Stout et al., 2011) and protect their performance when negative stereotypes are salient (Marx and Roman, 2002).

Another gender difference in terms of role models pertains to the teacher as a role model. In women's narratives on occupational choice, encouraging teachers (e.g. chemistry, mathematics or physics high school teachers and university advisors) are regarded as vital. For instance, Demet's teacher in high school was critical as her role model and source of motivation towards her occupational choice:

> "…I had a teacher in high school who I loved so much. I still meet her sometimes. She motivated me that I was a strong, smart person capable of doing anything that I would like." (Demet, 31 years old, Electrical Engineer, Technopark ICT firm)

Similarly, Nurcan's teacher, who encouraged her to participate in scientific projects and competitions, influenced her occupational decisions:

> "..My role model is my chemistry teacher in high school. we used to have extra projects and our high school was an active school and our principal supported us. We were doing projects and I enjoyed that very much. I became fond of doing projects, winning awards, and I was keen on chemistry." (Nurcan , 27 years old, Chemical Engineer, Electronic-R&D Center)

The importance of teachers in the formation of students' perceptions on educational and disciplinary decisions has been noted in various studies. For instance, one international comparative study on students' science-related attitudes, the Relevance of Science Education (ROSE) project, found large differences in students' attitudes, which suggests that schools and teachers play a pivotal role in stimulating students' attitudes (Sjoberg and Schreiner, 2005). According to another survey conducted in a Turkish technical university, career services and family members are the two major influences on students' occupational decisions (Bucaka and Kadırga, 2011).

Another gender difference in terms of occupational decisions was the common emphasis of male researchers on their interest and enthusiasm in technological fields starting from a very early age, whereas only one female interviewee, Demet, mentioned an early interest in natural sciences and technical fields. In this case, positive role models and their encouragement were critical. While the women develop an affinity for these fields through various teachers, relatives and family members during their educational years, male researchers underline their early curiosity for science, research and technology in their narratives on natural sciences and technical fields. This emphasis on curiosity without any reference to role models, as being "automatic," or a "childhood passion" is a gendered narrative. Invention appears to be a male childhood dream as far as the narratives in our research showed:

> "…When I was a child, I was known as the inventor. I had activities in very different fields, such as models, aero planes, machines, chemistry. ...Therefore, everybody was already expecting me to be an engineer." (Cem, aged 43, Structural Design Engineer, Durables Manufactıres R&D)

> "…When I was a child, there was a TV series called "The Wheels." In the program, they were designing automobiles. There were some scenes that displayed the works of those designers in the field of aerodynamics. I liked it very much; I liked the construction of a machine. The machines with the greatest amount of spirit, I believe, are cars. I believe I have a special competence and talent for machines and design. After my circumcision, people gave me some car toys. I used to open their covers and examine them; I used to try to make other cars similar to them. I was fond of mechanics." (Demir, aged 45, Mechanical Engineering, Automotive R&D)

In cases with no role models, women's narratives on engineering are often explained strategically, such as by "the choice of the successful student" or "choosing the university with the highest score." Among the engineers, technicians and expert women, we did not encounter any narratives about being inclined towards science starting from a very early age. Stereotypes that men are naturally more talented and interested in mathematics and science are thought to influence the science, technology, engineering and mathematical aspirations and achievements of boys and girls, men and women (Nosek et al., 2009).

Although most successful female and male students are encouraged towards science and mathematics due to their high university entrance exam marks, female narratives about "having a capacity in mathematics" are quite different from male narratives about "growing up with an enthusiasm for science." This difference can be explored with reference to the fact that women tend to underestimate their abilities to be successful in STEM fields (Cheryan et al., 2011; Sikora and Pokropek, 2011). For instance, Correll shows that males assess their mathematical competence more positively than females of equal mathematical ability (Correll 2001; 2004). Exploring gender segregation in adolescent science career plans for 50 countries, including Turkey, based on data from International Student Assessment Survey, Skora and Pokropek (2011) found that, almost everywhere, boys have more confidence in their scientific ability than girls, even after science performance is taken into account. The gender difference in terms of their narratives on their interests and choices confirms the existence of "biased self-assessment", which can be explained with reference to dominant prejudices and stereotypes in STEM fields. In discussing their career choices, male and female researchers with similar educational backgrounds and similar workloads evaluated their scientific abilities differently.

A substantial proportion of the interviewees working in R&D centers were educated in special public high schools with a foreign language of instruction, usually English, or in natural sciences oriented special schools (16 out of 19 interviewees). Hence, the central examination system to enter these special schools can be critical in minimizing science gender biases, at least in undergraduate education.

Women educated in male-dominated fields also report the existence of academic staff who participated in reproducing gender stereotypes and regarded women in the field as secondary. For example, in mechanical engineering, female graduates noted that the ratio of female students was below 10% in their departments, that the department was "the natural social environments of their male friends", and that some professors believe that women are not capable of being a mechanical engineer:

> "…Therefore we lived amongst the men. When you have a campus, there are other girls from other departments. But we spend our 4 years with men simply tolerating their rude behavior... In the lectures, you can sense that some professors did not like girls. Old-generation professors from the German tradition used to believe that women cannot undertake that occupation. (Pelin, aged 35, Mechanical Engineer, Durables Manufactures R&D)

Especially in interviews with female researchers educated in "masculine" engineering departments (Zengin, 2002), such as mechanical, metallurgical, electrical and electronics, deep-seated gender biases and stereotypes were often emphasized. According to Zengin, engineering departments can be categorized into three groups: the first is the masculine departments listed above; the second is the "feminine" engineering departments, such as food, chemical and environmental; and the third is a "mixed sex group", including geological, industrial, mining and computer engineering (Zengin, 2002). Ayşe's choice of chemical engineering shows us how engineering stereotypies are deep-seated:

> "…Yes, there was a school that I wanted to go. There were departments that I was thinking about. But, if you ask me why you chose chemical engineering instead of mechanical or civil engineering... I can say since I thought that I was inclined to chemical engineering as a lady, I simply chose it. Yes, maybe, it was the only criterion. Besides this, there was not such a situation as if I definitely wanted to become chemical engineer or I had role models." (Ayşe, aged 30, Chemical Engineer, automotive R&D)

Gender segregation in occupations is mostly described in two ways. One concerns horizontal gender segregation, which implies that "men and women have different occupations, work within different sectors, have different employers and different places of work" (Berggren, 2008:25). The second is vertical gender segregation, which is about gendered career making, where men are more likely to reach the highest positions. Though "successful" and "hardworking" female students are encouraged to register in the natural science departments, deep-seated prejudices and stereotypes in the field of STEM are still critical in terms of shaping women's choices in engineering departments. Industrial, chemical, textile and environmental engineering are the "feminine engineering departments", with higher ratios of women. Filiz's narrative on her occupational choice exemplifies the dynamics that lead successful female students to engineering departments and horizontal segregation:

> "…Well, I never wanted to be an engineer with all my heart. My father is an engineer. Back then, I was open to guidance and I was a hardworking student. You know that students in the science branches were regarded as better students; there was such guidance. ... I could have been an electronic engineer. I checked its courses but they were not… It is as if I, as a lady, am more interested in clothes; that choice is a result of this. When I checked its courses, they attracted me." (Filiz, aged 36, Textile Engineer, Durables Manufacturing R&D)

In our research, female researchers also reported being encouraged by their families towards ICT, electronics and computer engineering. ICT and computer engineering are regarded as safe future jobs that are accessible by women too. Turkey's ICT sector, with a female ratio of 32.7%[5] has proved to be a field where the desires of families for a promising job for their girls and boys can be fulfilled. Similar results are shown by research on the Bulgarian ICT sector by Gharibyan (2006), who explains Bulgarian women's strong representation in computer science

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[5] For the Turkish Information Technology Sector Association's (TÜBİDER) latest research on the wages of ICT employees, see: http://www.tubider.org.tr/?p=2342

programs through "the absence in that culture of an expectation that one will "love" one's job." Instead, both men and women are attracted to computer science because of its potential to provide a financially secure future" (in Charles and Bradley, 2009: 959). Charles and Bradley (2009), in a comparative study of 44 countries regarding sex segregation by field of study found a general tendency for greater segregation of academic fields in more economically developed contexts. In other words, sex segregation by field of study is, on average, more pronounced in advanced industrial societies. According to Charles and Bradley, "instrumental goals of material security and national economic development are decreasingly central to curricular decisions (by students themselves, parents, family members, and educational gatekeepers) as national prosperity grows" in developing countries.

In Turkey, the proportion of female researchers in the STEM fields is higher than in Western countries, which requires us to scrutinize the gender segregation regime with a focus on occupational career paths in the STEM fields.

Gendered Segregation among R&D professionals in the Workplace

The interviews for this study, conducted in R&D centers and a university technopark, focused on women's career experiences in R&D and innovation. Acker distinguishes occupations from jobs: "An occupation is a type of work; a job is a particular cluster of tasks in a particular work organization." According to Acker, "'job' is the relevant unit for examining segregation in organizations". Acker refers to research indicating that "sex segregation at the job level is more extensive than sex segregation at the level of occupations" (Wharton, 2005; 97 in Acker 2006:446).

In this study, we focused on R&D jobs in 3 large private sector R&D centers and university technopark firms. Differences between these two company structures had a significant effect on different gender-based career experiences. The companies in the technoparks are generally active in the ICT sector and have weaker organizational hierarchies and structures. As Valenduc et al. (2004) note, ICT organizations have a flat structure with little hierarchy, which leads to an informal working environment. In contrast, R&D Centers operate in the field of manufacturing, with more hierarchical institutionalized structures, where more detailed career ladders are defined.

In the in-depth interviews, female researchers in the R&D centers were more positive in terms of employment, career processes, motivation and home-work balance than their counterparts in the university technoparks. Though they have more informal and vertical structures, small R&D and innovation companies and start-up firms tend to have negative implications for female researchers. In our interviews, female researchers in small-sized innovative enterprises mentioned problems such as the "one man's firm" structure, lack of seniority and promotion balance, short and even non-existent career ladders, tight old-boys networks as a way of doing business, high turn-over rates among employees, irregular working hours, masculine working environment and gender bias, and unpredictable workloads. Filiz, who was employed in such a small innovative enterprise after graduation, underlines the difference between two structures:

> "…Well, the orders should be quickly delivered; when something is delayed, there is more of a panic; it is a boss's company. It was all chaos. I would like to have had a more organized, planned job. For instance, we could have a project funded by TUBİTAK and we have deadlines set beforehand that I will follow during my work." (Filiz, aged 36, Textile Engineer, Durable Manufacturing R&D)

Similarly Fahri, a male software specialist in an ICT firm in the technopark, explores the differences in terms of gender dynamics between different company structures:

> "…I think that there is a negative approach towards women in this sector in Turkey - especially in small firms. In more institutional settings, there is a more homogenous structure since they are more institutional. With less segmentation, the number of women is smaller. It is an unjust situation that they have the idea that women cannot fulfill this task."(Fahri, aged 23, Math Engineer, University Technopark ICT firm)

In a study on the gender gap in Germany's information technology sector, Ben (2007) also concludes that working conditions in small software enterprises are much more precarious and that the life–work balance is very difficult in these organizations. The accounts of female researchers in corporate R&D centers differ from female employees in small and medium sized technopark firms in terms of career paths, regularity and specificity of tasks:

> "…In terms of mechanical engineering, we can see that there is an increase in workplaces in which women can feel more comfortable. As I have mentioned, R&D is a field in which gender discrimination is less effective. The increase in R&D spending, the expansion of the fields of mechanical engineering, the increasing use of mechanical engineering in industry makes mechanical engineering popular irrespective of gender." (Mustafa, aged 34, Mechanical Engineering, Durable

Manufacturing R&D)

> "Working in a corporate firm really has its good sides. You have additional rights, and it is like getting employed by the state. It is open to rotation, you can move to somewhere else if you are bored. The firm gives a lot of confidence." (Melek, aged 28, Textile Engineering, Durables Manufacturing R&D)

Similarly, Wickham et al. (2008) challenge the argument that bureaucracy is inherently patriarchal and, through a study of software firms in Ireland, claim that bureaucratic companies benefit women more than non-bureaucratic, individualized companies, which tend to be more hostile to women. In an early research, Mcllwee and Robinson (1992) also concluded that women's career mobility is greatest where the masculine culture of engineering is minimized by bureaucracy.

However, in the Turkish case, our research highlights that the main reason why women positively assess more institutionalized structures of R&D and innovation is not the opportunities for upward mobility but their general perception of R&D as a safe, well-planned and regular job. Though career ladders don't often lead to the higher levels for female researchers, R&D nevertheless offers women the opportunity for getting regularly promoted. However, it seems still very hard for women to gain promotion to managerial levels: for instance, in the three R&D centers in our research only 1 in 10 executives was female, while in the technopark companies only 4 out of 54 executives were females. This aspect of the private sector is similar to academia in terms of its employment patterns (Sağlamer et al., 2013). Female researchers explained their distance from middle and upper management levels:

> "…Here, the structure is that all the directors and executives are male. Furthermore, career paths in R&D are fewer, slow and different....Your options in other sectors such as marketing etc. are closed. You remain as an R&D person." (Müjde, aged 43, Electronics Engineer, Durables Manufacturing, R&D Center)

> "…I don't have huge ambitions about leadership, but when you look at the situation you are promoted less." (Filiz, aged 36, Textile Engineer, Consumer Durables, R&D Center)

Internal Gender Segregation

According to Sou (2004, in Berggren, 2008; 25), jobs, occupations and tasks may be internally segregated by gender, meaning that "men and women who hold the same occupation, and work at the same place, are steered toward different types of tasks or have chosen different specialties." Acker (2006) underlines the necessity to scrutinize the gender division of labor at different levels; that is, the reproduction of the gender differentiation of jobs and tasks in the same occupational field which leads to the reproduction of gender division of labor in the institutional level and regimes of gender inequality.

In our study, instances of internal segregation in R&D and innovation include female employees in the automobile sector who graduated from engineering departments like male employees but who are employed in cost finding, planning and reporting tasks. In the manufacturing sector (consumer durables and home appliances), female employees are employed in the food technologies and cleaning technologies departments, while in the field of ICT they are mostly employed in marketing and those fields which include customer relations and soft skills:

> "…Well, it is like "you have communicative skills, you can do it much better." I don't know whether I should think of this as gender discrimination. Indeed it can be a prejudice. But I should also accept the fact that nobody ever told me I was incapable of doing anything as a woman. After getting to know me, there was some guidance in the form of "you are good at these tasks and these tasks are hard for software engineers who are fond of software, developing codes, etc., but not willing to communicate with people. But you can do both. So can we take you this side please?"(Demet, aged 31, Electrical Engineer, Technopark ICT firm)

The horizontal segregation that we mentioned in curricular decisions is reflected in the organization of R&D work. This segregation is based on beliefs that construct women as innately "more competent than men in service, nurturance, and social interaction" (Charles and Grusky, 2004; 15), whereas men are assumed to be naturally more adept at problem solving, analytical tasks, and complex abstract reasoning" (in Acker, 2006; 446).

> "…It is like you cannot cook half of the meal today and half of it tomorrow. The product is brought to me from the grocery store; I take care of it in its every moment from preparation till cooking. (Esma, aged 36, Food Technologist, Durables Manufacturing R&D).

Acker acknowledges that there is less gender segregation than 30 years ago within the broad level of professional and managerial occupations. However, research indicates that "sex segregation at the job level is more extensive than sex segregation at the level of occupations" (Wharton 2005, 97 in Acker, 2006, 446).

Acker concludes that the apparent reduction in segregation may in reality only be a reconfiguration: “Reconfiguration and differentiation have occurred as women have entered previously male-dominated occupations” (Acker, 2006; 446). In the R&D centers in the durable goods and home appliances manufacturing sectors where we conducted our interviews, though more than 70% of the employees in the field of cleaning technologies are female, there are very few women in the thermodynamics field. The gendered differentiation of the mechanics of the oven and the refrigerator, and the technologies of cooking and keeping the food indicates a similar reconfiguration in the organization of engineering.

Another pattern our study found for women from the STEM fields was that they are either guided to or tend towards less technical fields based on social and personal relations. This inclinations seems especially so for women in ICT and software:

> “…In my previous job, I asked them not to be in customer related tasks and it was a good for me. And now I never asked for my current job, they offered me because they thought that I could be successful.” (Demet, aged 31, Electrical Engineer, Technopark ICT firm)

One of the basic reasons for women to have a career in R&D is the difference between R&D engineering from site engineering. As Ismail (2003) notes, historically, the image of engineering has been heavy, dirty and involving machinery, with women’s success often depending on adopting an explicitly male career pattern. These images of the masculine engineering areas not only affect departmental employment policies but also career paths in different engineering fields. In particular, female employees in corporate R&D centers defined their professional field and their choices for R&D in terms of “the difference from site engineering”:

> “…When I was a graduate, R&D seemed to be very unreachable for us. There was something utopian like “the companies are making R&D, they are researching and developing.” When I started my vocational training in this company… when I gained a level of competence in the field and enjoyed being in my firm, especially when compared to industry with stressful working hours.” (Nehir, aged 29, Chemical engineering, Consumer Durable Sector R&D Center)

In their narratives, women who chose R&D engineering often emphasized regular working hours, “clarity in task,” “planned tasks,” “respectable working environment,” “distance from the factory,” “qualified team members,” flexibility, academia-like work and staff.

> "…The closer is the sector in which you work to home, the higher is the ratio of woman. For instance, some civil engineers have to work on site. Those who work in the office rather than the site are a very small group within the labor force. Same for the mechanical engineering, they work on construction sites, in factories. I don't know the percentage of women here but they are not too many. Given this, why should one hire the employee with fewer opportunities? Although… ladies are responsible for all the things in the house. However modern it is, Turkey is not ready for it. This is why our proportions were equal since we were going to work in the office."(Defne, aged 26, Math. Engineering, Automotive R&D)

Defne's definition of a job "which is not far away from home" refers not to a physical distance but rather the distance between technical and site engineering and R&D. Through this narrative, Defne accepts the narrow space in which women are compressed in the field of engineering. According to one survey of engineering departments, female students believe that they have fewer opportunities than male peers and acutely feel the lack of role models (Smith and Dengiz, 2009).

Furthermore, male employees in the male-dominated R&D departments employ gendered stereotypes in the field of engineering, referring to fields that are "suitable" for women and those that are not:

> "…When you graduate from mechanical engineering, you generally become someone working in the manufacturing of a machine. In those production sites, those people you work with are socially and culturally different from you. As that level decreases, the attitudes towards women start to change. According to me, this also leads to women's discomfort with employees in the lower levels. … But in our field, since we are distanced from manufacturing, we have an office setting." (Kıvanç, aged 31, Mechanical Engineer, Consumer Manufacturing R&D)

Though the horizontal, vertical and internal segregation in the fields, jobs and occupational decisions among R&D employees in Turkey display some similarities with those discussed in the literature, they also display some peculiar characteristics of the gender regime in Turkey. Career paths in R&D are also the reflections of bargains with, and strategies *vis-a-vis* the gender regime.

Women from STEM fields distant from site engineering and conscious of their distance from the managerial positions, are concentrated in R&D fields in which, they believe, they can be at ease with their work and home balance, and do jobs and occupy positions that require more indirect, supportive and soft skills.

Conclusion

Turkey enjoys one of the highest proportions of women in engineering, comprising 27% of the engineering workforce, compared to approximately 11% in the United States. However, the higher numbers in STEM fields in Turkey can be explained with reference to some aspects of education, economic and sociopolitical dynamics and the characteristics of the gender regime in Turkey rather than gender equality. First, given the fact that there is a negative relationship between R&D and innovation spending and the proportion of women in these fields, the high proportion of women in innovation is a result of Turkey's status in the global market for innovation and R&D. Secondly, the fact that Turkish women have in recent decades gained access to good quality public education in foreign languages via a central and gender-neutral university entrance examination seems to have led to a comparatively egalitarian dynamic as far as gender and class are concerned[6].

Thirdly, universities and public education in Turkey had been organized so as to include women in natural sciences and engineering fields in the early years, as seen for instance in the relatively higher number of women in natural sciences and engineering in established universities such as Ankara University (Köker, 198; Sağlamer vd., 2014).

However, these egalitarian dynamics are limited by neoliberalization in education policies and the characteristics of the gender regime in Turkey. The decrease in schools providing good quality public education in foreign languages in the last decade will inevitably result in an increase in class and gender inequalities in STEM fields in Turkey.

In addition to those tendencies, approaches which define women first and foremost through motherhood and family are critical in terms of their effects on women's career experiences. Social policies in Turkey, starting from the early years of the Republic, have perceived women not as an essential component of the labor force but through a family model in which men are regarded as the breadwinner (Öztan, 2014).

A job in corporate R&D that is usually achieved by "hard-working girls,"

[6] However, changes in the education system (in school systems regarding the public schools and the expansion of private education at all levels) in the last decade may reverse this relatively egalitarian aspect.

educated in public schools and encouraged by their families and teachers, is a result of a bargain with the patriarchy. As 30% of the engineering labor force is female, some women in engineering are oriented towards corporate R&D because it is a "respectable," "homely," "proper" and "qualified" field of work. Within this field, in terms of terms of tasks and responsibilities, women are further concentrated in more "feminine" departments and positions. In particular, women employed in small innovative firms are oriented towards fields that require soft skills, such as customer relations and marketing.

One of the reasons for women's orientation towards R&D and innovation pertains to the gender regime in Turkey. In the West, gender differentiation in STEM fields relates to scientific competence and qualifications as a result of essentialist gender arguments. In Turkey, however, rather than an essentialism based on the exclusion of women from reason and science, this is an essentialism that defines them through body, chastity and family. Hence, what matters in Turkey is not whether or not women can be mechanical engineers or aeronautical engineers but that they work in "proper" settings and in "proper" ways. Therefore, women prefer fields that are more "sterile", "close to home," distant from the factory and its masculine character, and that will not put pressure on the home-work balance.

However, in these fields, female employees tend to experience distance from managerial positions and feminine tasks. Rather than an occupational segregation, we can observe a reconfiguration of job fields and the formation of new segregation forms that reproduce gender inequalities. Hence many job fields in engineering are post-graduation jobs for women to gain experience before they get married or have children. These experiences of the R&D female labor force are further consolidated by a gender regime in which only a small group of educated women works in the formal sector and in white-collar jobs, in which even women with occupations leave the job market at a late age, and in which the female labor force is small.

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