TECHNOLOGY DEVELOPMENT IN TURKISH AUTOMOTIVE INDUSTRY: A CASE OF MIDDLE TECHNOLOGY TRAP

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Approval of the Graduate School of Social Sciences

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ABSTRACT

TECHNOLOGY DEVELOPMENT IN TURKISH AUTOMOTIVE INDUSTRY:
A CASE OF MIDDLE TECHNOLOGY TRAP

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This dissertation questions the dynamics of leapfrogging by focusing on technology developmentin the Turkish Automotive Industry. We abstract from the research questions whether automotive firms in Turkey are investing in more sophisticated R&D projects that have potential to generate higher value-added and whether this process has led to a catch-up or leapfrogging. In order to investigate thesequestionsthis dissertation uses a mixed approach involving both quantitative and qualitative methodologies. In the quantitative part, TTGV data involving

submitted projects supported by TTGV in the automotive sector between the years 1991 and 2011, has been utilized. Thus, we are able to observe a time period of 20 years to investigate whether technological knowledge developed by the automotive firms become more sophisticated through time. In the qualitative part, the findings from TTGV data has been combined with the views of high status experts in the domestic industry and selected firms from the TTGV sample in order to deepen and validate our findings. The findings suggest that Turkish firms are mostly performing similar projects mostly at the traditional level of R&D in the automotive industry and with the exception of some examples, contemporary fields such as electronics, embedded software, telematics, smart cars, fuel efficiency in engines are not at the focus of the national industry. Turkey looks more of a manufacturing centre rather than a hub specialized in R&D. JV-dominated structure was effective in the establishment of national industry, however, this thesis argues that it is also an important impeding factor to further foster the current state of the industry since the main strategic decision-making processes of Turkish R&D and automotive industry is being done abroad. Given this situation, we assert that Turkey is in a middle-technology trapsuggestingthat Turkey's position as a latecomer has reached a level of maturity but this development will not continue unless the government actively plans further development strategies. In order to overcome the middle technology trap, some policy recommendations such as establishing more sophisticated supplier industry with intensive R&D base, participating in knowledge intensive international networks and implementing more activepolicies by the government that aims at creating markets rather than fixing markets are being offered.

Keywords: technological sophistication, middle technology trap, automotive industry, catching up, leapfrogging

ÖZ

TÜRK OTOMOTİV ENDÜSTRİSİ'NDE TEKNOLOJİK GELİŞİM:
BİR ORTA TEKNOLOJİ TUZAĞI VAKASI

Bürken, Serkan
Doktora, Bilim ve Teknoloji Politikası Çalışmaları
Tez Danışmanı: Yrd. Doç. Dr. Semih Akçomak

Eylül 2014, 267 sayfa

Bu tez, Türkiye'nin kendisi için büyük önem arz eden Otomotiv Sektörü'nde sıçrama yapıp yapamadığını mevcut Ar-Ge projesi faaliyetlerine odaklanarak sorgulamaktadır. İlgili araştırma probleminin sorgulanabilmesi için nicel ve nitel çalışmalardan oluşan bileşik bir araştırma yaklaşımı kullanılmıştır. Buna göre, ilk olarak nicel çalışmada, TTGV arşivinde bulunan Ar-Ge destek dosyalarında yer alan ve son 20 senede TTGV'ye yapılan Ar-Ge proje başvuruları arasından uygun veriler toplanarakprojelerin teknolojik sofistikasyonu sorgulanmıştır. Nitel analiz kısmında ise, Türkiye Otomotiv Endüstrisi'nde söz sahibi profesyonellerle ve

seçilen firmalarla uzman mülakatları ve firma ziyaretleri gerçekleştirilmiştir. Bu çalışmalar sonucunda, yeni bulgulara erişilmiş, mevcut bulgular kontrol edilmiş ve geliştirilmiştir.

Gerçekleştirilen araştırmalardan Türkiye'nin genel olarak daha geleneksel otomotiv teknolojilerinde Ar-Ge projeleri yaptığı ve telematik, elektronik kontrol sistemleri, motor ve yakıt sistemleri, gömülü yazılımlar gibi daha çağcıl ve katma-değeri yüksek teknoloji alanlarında birkaç örnek dışında varolmadığı ortaya çıkmıştır. Çok Uluslu Şirketlerle ortak girişime (JV) dayalı yerli firmalar, ulusal sanayinin gelişiminde büyük katkı sahibi olsalar da, halen karar alma süreçlerinde ana firmaya bağımlılık Türkiye'nin Ar-Ge'de sıçrama yapmasını engellemektedir. Bu durum, literatürde yeni bir kavramla adlandırılmış; Türkiye gibi Ar-Ge süreçlerini daha karmaşık hale getiremeyen, ama üretimde belli bir yetkinliğe ve yoğunlaşmaya sahip olan geriden gelen ülkeler "orta-teknoloji tuzağında" olarak isimlendirilmiştir. Son olarak, Tez kapsamında bazı politika önerileri geliştirilmiş; orta teknoloji tuzağından kurtulmak için Ar-Ge yoğun tedarikçilerin desteklenmesi, uluslararası bilgi ağlarına ve projelere erişim ve küresel karar alma süreçlerine daha kuvvetli katılım içinaktif devlet müdahalesini ve mevcut destek yaklaşımının değiştirilmesini de kapsayan bazı politika ve stratejiler önerilmiştir.

Anahtar kelimeler: teknolojik sofistikasyon, orta teknoloji tuzağı, otomotiv endüstrisi, öndekini yakalama, sıçrama

To my beloved mother who cares me insanely,

To my yearned father who is now in eternity,

To my truehearted uncle who contributed much to my personality,

and

To my lovely grandmother who is waiting for me to hear "I am a PhD".

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The author also wishes to thank all the experts and firms who contributed much to case studies.

The technical assistance of Mr. Serkan Aksoy, M.Sc., is gratefully acknowledged.

This study was realized by the data provision of Technology Development Foundation of Turkey (TTGV). All the data being used was confidential; project and firm names were not given throughout the study. I would like to acknowledge that the provision of data by TTGV was an invaluable contribution to this study.

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CHAPTER 1

Introduction

1.1. Problem statement

There have been dramatic changes in the functioning of industries as globalization widens and deepens. With the ease and common use of information and communication technologies (ICT), tacit and codified knowledge can disseminate widely throughout industrial hubs and networks– a fact which forces organizational structures of the contemporary industries to change. Today, most industrial policy-makers design policies that strategically specialize in a selected area of expertise in order toplace the domestic industries (thus the countries) at a higher level in theglobal value-chains. Knowledge is the most prominent source of competitive advantage and now is accepted as a classical production factor like labour, capital and land. The struggle among countries has also altered-as Arrighi (1994) claimed in his seminal book, *The Long Twentieth Century* - territorial concerns of countries, which have repercussion effects inthe economy, since the importance of classical factors such as land and labouris being replaced by more soft factors such as knowledge. Thus, competitiveness sustained through knowledge has become the most eminent factor for the survival of countries.

In this general framework, automotive seems as one of the most important industries for countries with its provision of externalities for economic development. A successful automotive industry provides widespread employment and with its inherent technologies based on different parts of components in an automobile - both electrical and mechanical, has a great range of technology

diffusion effects throughout the economy. Automotive industry has passed through several phases of development from its very foundation started about one and a half century ago with craft-based production; and has actually transformed into a global industry containing industrial hubs and clusters located in the centre as well as periphery countries. In its current organization, automotive industry is structured as a global value-chain dispersed throughout the world where each country is playing its own role in manufacturing and knowledge production. The industry is constituted by multi-national Original Equipment Manufacturers (OEMs) and component-system suppliers reaching volume of revenues that can be compared with Gross Domestic Product (GDP) of developing countries. In addition, suppliers from tier 1, tier 2 and tier 3 cluster around these large firms connected to each other horizontally and vertically in a highly complex network structure. In terms of end-producer brands, the industry has been extremely consolidated, and in the upper parts of the value chain involving OEMs and system suppliers, there is a strong tendency of firms towards establishing mergers and acquisitions to survive.

As a latecomer, in Turkey, very first auto production plant was established by Ford Motor Co. in 1929. The industrial efforts were intensified in 1950s with the establishment of truck and tractor plants and automobileproduction started in 1960s by assembling imported parts under a given licence. Turkish Automotive Industry is now composed of several Joint Ventures (JVs), domestically-owned manufacturers of trucks and defence vehicles and foreign direct investments of global OEMs. Turkey has been generally placed at the periphery of industry by using its low cost advantage in production, which over the years has transformed the country into a centre of excellence in manufacturing with increasing Research and Development (R&D) efforts. In this conjuncture, there is a hot debate of having own national brand, which was also a hot topic of the 1960s during the very first introduction of a fully Turkish-made car, Devrim.

We outline the general framework of the global and domestic automotive industry abovewhich still has a dominant position in the global manufacturing processes and technologies. Under this conjuncture, by notifying the current state of both the

global and Turkish automotive industry, the main aim of this dissertation is to analyse whether there is a kind of technological catching up or leapfrogging in the Turkish case. The main question of the thesis can be stated as follows: By generating more sophisticated R&D and technological knowledge,hasthe Turkish automotive industry produced more advanced manufactured products and processes over the years? Is there a catching up or leapfrogging in this sense?

To answer this question, we initially offer the definition of technological sophistication in R&D as:

Technological sophistication can be defined as a state where technologies depend on novel R&D projects that involve higher value-added, that aim to attain high level of innovation within contemporary technologies of the current automotive industry, and that are based upon design intensive products/processes without depending upon OEMs as customers or know-how providers.

In accordance with this definition, in the core part of the dissertation, we utilize a mixed approach including quantitative and qualitative methods on the basis of this definition. On the quantitative side, we benefit from a successful R&D subsidization programme of Technology Development Foundation of Turkey (TTGV). We obtained data for the 86 submitted R&D projects on automotive performed in different firms between 1991 and 2011. Given this data, we establish a main hypothesis that investigates the level of technological sophistication over the years.

On the qualitative side, the first case study is the firm visits involving semi-structured interviews with automotive firms, which submitted their projects on the R&D support programme of TTGV. These interviews have provided us an in-depth analysis of what we have found from the TTGV data at the R&D project level. Subsequently, the second qualitative study includes semi-structured interviews with the high level experts of the Turkish Automotive Industry. This study has provided invaluable insights of macro conditions surrounding the industry in the context of technological sophistication.

The findings show that there is a strong dependence of the Turkish Automotive Industry on foreign affiliates (Chapter 4, 5 and 6). Despite some design intensive R&D projects assigned at the end of the 90s and at the beginning of 2000s, JVs in particular and Turkish Automotive Industry in general, obtain the main specs from the OEMs and are not able to participate design and design confirmation processes, to a wide extent (Chapter 5 and 6). Except some particular examples, Small and Medium Sized Enterprise (SMEs) in the automotive industry are not able to pass into a phase of co-designing. Additionally, experts generally argue that Turkey has not managed to catch up when we analyse Turkey's position in the global industry (Chapter 6). Despite recent export success, Turkey seems only as a centre of excellence in manufacturing and has vast difficulties in transformingits industry into a knowledge intensive R&D hub in the global value-chain. We refer to this situation as "middle-technology trap" which can shortly be defined as a technology regime that is positioned at the lower tiers of the global value-chain with its excellence only in production rather than R&D (Chapter 7).

In short, the dissertation is essentially based on the technological development paths including catching up and leapfrogging on the basis of technological sophistication. It contributes the literature in the given areas stated below:

- Proposition of a novel approach for catching up and leapfrogging including a mixed analysis employing both quantitative and qualitative methods, to illustrate a given country's position in the global value chain of a given industry,
- A novel way of evaluating R&D funding programmes with an in-depth analysis of each project in terms of technological sophistication,
- A very detailed analysis of the Turkish Automotive Industry that includes both quantitative and qualitative aspects which provides cross-validation of the findings achieved in each chapter,
- Initiating concepts such as technological sophistication and middle-technology trap that can be investigated in detail in further studies.

In the subsequent section, we propose a detailed outline of each chapter.

1.2. Chapter outline of the dissertation

As the starting point, Figure 1 displays the roadmap of the problem statements guiding the research design and chapters throughout the dissertation.

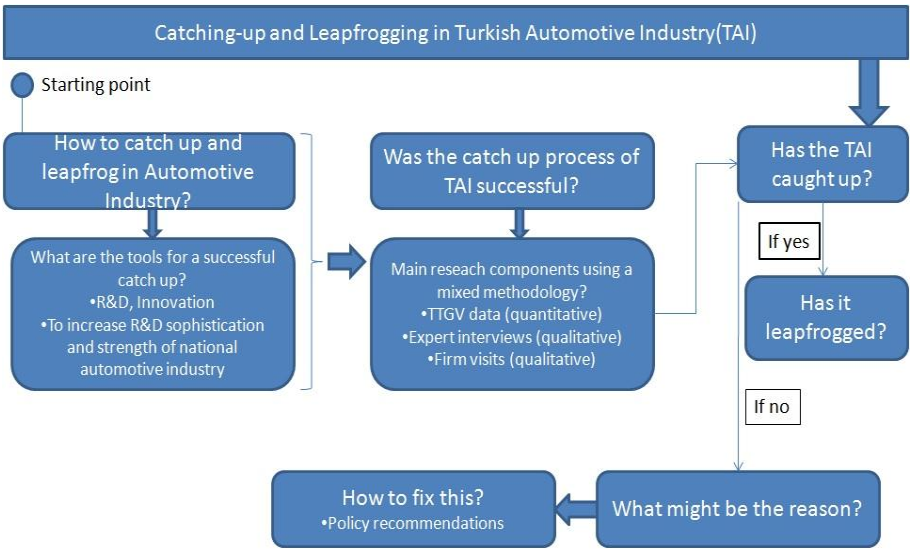

Figure 1 The roadmap of the thesis

As seen in the figure, we start our study by investigating the literature on catching up and leapfrogging that we benefit in the thesis in great extent. We then emphasize the current findings related to Turkish and global automotive industry. We explain the arguments of government intervention and technology policy measures in relation with both market failure and systemic failure approach in order to determine possible bottlenecks in the innovation system and to explain how to fix the problems. Consequently, we discuss how to use these findings in the Turkish Automotive Industry to provide policy recommendations.

In chapter 3, we explain the methodology of our research. Beginning with our main hypothesis and research questions, we represent our methodology involving both quantitative and qualitative parts. This thesis proposes a detailed methodology involving three different case studies. Quantitative and qualitative parts are blended to answer the research question depicted above. This methodological design

enhances the findings of the research bu providing cross-validation and robustness. We begin by a quatitative evaluation on the project basis and then, expand it with micro and macro-based qualitative studies involving semi-structured interviews with firms and experts.

Chapter 4 involves the main part of our exploratory research on the TTGV database. Data on the submitted R&D projects on automotive over the past two decades from 1991 to 2011 has been gathered from the factsheets of each project. Using a novel classification of projects (traditional vs. contemporary) and by looking at usual suspects such as R&D expenditure, project numbers, innovativeness, export behaviour etc. we try to analyse whether sophistication level of the technology in the Turkish Automotive Industry increased over the years in the last two decades. The results show that Turkish Automotive R&D is quite stable in terms of the level of technologies, R&D and technological knowledge creation. Thus, one can assert that projects that have similar potential to create technological knowledge over the yearsare being subsidized.

In chapter 5, we conduct a micro analysis on the firm basis to assesswhether there is a tendency to be involved in R&D that has potential to create more sophisticated technological knowledge. By using semi-structured interviews, we gather information about the R&D projects and past and current capabilities of the firms in terms of R&D and we find that Chapter 5 validates the findings in Chapter 4. We suggest that these concurrent findings increase the validity of the main results in this thesis. The results show that Turkish Automotive Industry has not yet achieveda technological development process of catching up (not to mention leapfrogging).

In Chapter 6, we implement semi-structured interviews to experts whoare specialized in the Turkish Automotive Industry to obtain insights about the historical evolution of the industry to put forward current bottlenecks, past and current policy measures and the future trends. This chapter provides a macro base to the thesis to overcome the possible methodological and data limitations of

previous chapters. Chapter 6 can also be viewed as a further robustness study. One can easily see whether experts validate the project-level and firm-level findings about technological sophistication. This study also offers invaluable insights regarding the foreign dependency of Turkish JVs on the process of automobile design and manufacturing, limiting their capability to innovate by performing more sophisticated R&D.

In the final chapter, we evaluate and analyze all the findings of the thesis in a comprehensive manner. We speculate about the reasons behind the unsuccessful attempt of catching up of the national industry by addressing theproblems in the current system. Turkey's current state is referred as the "middle technology trap", a term we coin to explain a technological development state, which is good enough to master manufacturing but lacks technological knowledge production at the world frontier. Based on these findings, we recommend some policy measures in line with thefuture trends of the automotive industry in order to generate more value-added with more technologically sophisticated products. If successfully implemented, we assert that these policy measures would help Turkey to achieve a path for technological development andcatch up with the world leaders.

To sum up, the very first three chapters sets a ground for the research. Chapters 4, 5 and 6 constitute the core component of the dissertational research while Chapter 7concludes by summarizing the results and proposing policy by speculating on some aspects of our findings. A brief introduction of this interplay between the chapters is shown in Figure 2.

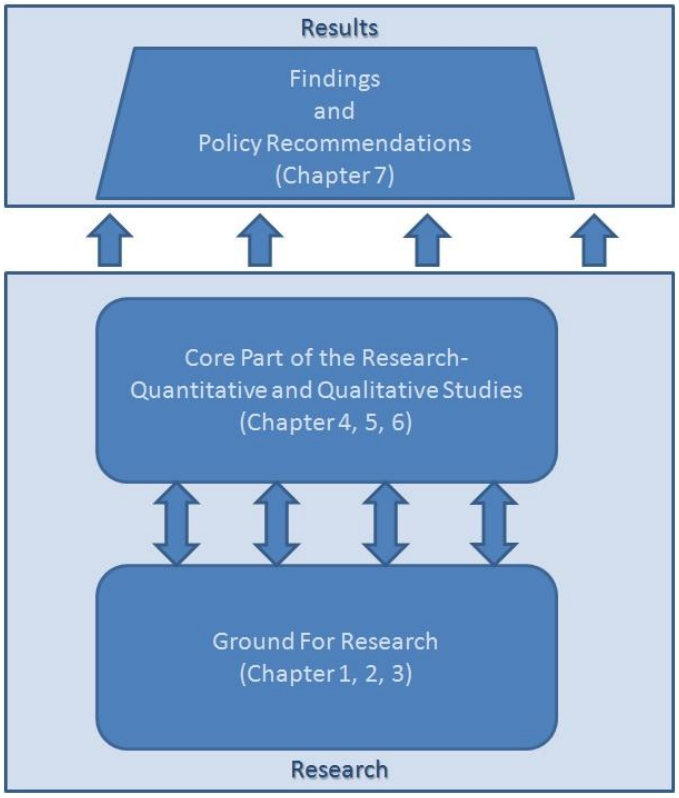

Figure 2 The interplay between the chapters of the dissertation

1.3. Scope of the dissertation

This study is based on the framework of catching up and leapfrogging in technological development and due to time, space limits and availability of data, it focuses on the R&D projects performed in the Turkish Automotive Industry in the last two decades between 1991 and 2011. The concepts of catching up and leapfrogging may be considered as the backbone of the study in order to comprehensively evaluate the level of technological knowledge in the automotive industry in Turkey. Surely, there are other determinants besides R&D projects that can be used for this evaluation; however, we strongly believe that it is a good starting point as we think of the emerging context of the literature establishing a tight connection among technological development and industrial catching up (Lee and Lim, 2001; Wang and Kimble, 2013).

We benefit from TTGV data involving 20 years of automotive industry applications to several kinds of R&D subsidy calls. This period is also important for its coverage of the whole subsidization history of the Turkish industry. Despite its limitations, we consider it is capable of explaining the track of Turkish R&D on automotive industry to a wide extent. We quantitatively analyse the R&D data in different time periods, which gives a dynamic setup to the thesis. To overcome some of thelimitations with the data, we apply two qualitative case studies to validate our results.

To conclude, this thesis is an attempt to evaluate the path of technological development by utilizing a novel approach of R&D subsidy evaluation and by enhancing the data work with expert and firm interviews. This thesis puts forward the current situation of Turkish Automotive Industry in a comprehensive manner with the definition of new indicators, methods and concepts.

CHAPTER 2

Literature Review and Theoretical Framework

2.1. Introduction

As the complexity of the industrial systems has boosted with the pace of globalization, interdisciplinary approach becomes more of necessity to address social and economic problems. This has changed the literature about industry, combining different disciplines such as science and technology policies, industrial economics, mainstream economics, evolutionary economics etc. While, on these topics, literature is expanding day by day, the industrial structure is also getting connected to each other more tightly and its complexity boosts; and thus, individual parts of the specific literature is not able to address new world problems.

With those facts in mind, in this dissertation, we discuss Turkish Automotive Industry and its pace of development. Given that the main hypothesis is about the comparative stagnancy of Turkish Automotive Industry in a global settingdespite the export success in the last decade; weinitially make clear that there is stagnancy in R&D performance. Accordingly, in this chapter, to draw a framework literature related to our case studies is examined.

Our main question is whether R&D in Turkish Automotive Industry has reached a level of sophistication that would enable cathing-up with the global leaders.Hence, we should reviewrelated parts of the literature to answer this question. We begin by posing how a nation which is formerly a developing one (alternately called as latecomer), can be described as a “developed” nation in a selected industry. How does industrial development take place? What are the paths and mechanisms that would enable countries to proceed to advanced levels of industrial development? In

order to answer these questions, we propose to use the terms *catching up* and *leapfrogging* which are commonly utilized to define paths for industrial (or technological)[1] development process of lagged nations. Accordingly, we firstly define and describe the context of these termsto establish defined variations of paths for industrial development. Another question to pose is about the tools we can use to support catching up and leapfrogging. Which tools can be utilized to ensure the reasonable conclusions on catching up and leapfrogging? Surely, industrial development is strongly related to R&D and innovative performances of nations. Here, an instant question comes: How can we develop industrial performances of nations? The answer comes from R&D funding and systemic nature of innovation to provide a comprehensive and complementary way to realize industrial development. Furthermore, in the case studies part to test our arguments, we benefit from R&D projects and we hold semi-structured interviews with experts and firms concerning with R&D and innovation within the selected industry. In the subsequent section, we define the terms of innovation, R&D, government intervention, R&D funding and related discussions in the literature and focus on how these conceptsare related to technology development in theautomotive industry to have a common understanding of the main subject of this dissertation. Given that the thesis is about automotive industry, we should further expand our discussion with the propositions of current literature concerning Turkish Automotive Industry. It means it is reasonable to combine the very findings with the suggestions of Turkey's current position. As a result, we come to the remarks section concerning the interrelationships between leapfrogging, catching up, R&D, innovation, R&D funding and Turkish Automotive Industry.

2.2. Catching up, leapfrogging and industrial development

Industrial development is a long-standing debate starting with early political economists such as Adam Smith and Ricardo. In his seminal book, namely The Wealth of Nations (1776), Smith claims division of labour among nations favours industrial development and broader specialization for any nation. As well as it

[1] In this dissertation, we are using industrial development and technological development interchangeably.

provides efficiency for the performed activity, it gives possibility to realize industrial development through specialization. Every nation should be responsible for taking charge of some parts of industrial activity in which it specializes. Ricardo (1821)further develop this understanding with the concept of *comparative advantages of nations* and advocated that every nation should perform the activities in which it has favourable advantages in their factor inputs.

One important contribution to this debate came from Freidrich List, in his groundbreaking book, namely, *The National Systems of Political Economy (1841)*. List essentially argues that developing nations should prevent their own industries until they pass through the phase of being infants to more advanced level of industrialization. In his opinion, England was consciously implementing protection measures and since they had become the superior industrial power, they were imposing free market policies to less developed nations so that they might take advantage of them. This was in favour of England with its advanced and technologically sophisticated products. England was importing raw materials and exporting industrial goods. It simply meant that England was selling more value-added products to other nations while buying goods with less value-added. The surplus had given wealth and superior power to England among other nations. List subsequently conclude that less developed countries of that era, such as Germany, should implement protection measures for their infant industries and free market policies should be in rule as the infant industries come to critical threshold as they are ready to free market competition. Even though he is opposed of free market policies, List rejects full protection through all phases of industrial development since it is not beneficial; and thus industries should become open to competition as they grow and reach to maturity phase.

Modern debates about catching up have risen after the World War II and considerable amount of research has been done. One of the basic interests of this research is the role of government and markets on development and catching-up processes of nations (Amsden, 1989; World Bank, 1993; Chang, 1994). In addition, like Porter (1990) and L. Kim (1997) there are also technology-based

views. At the first phase of this understanding, as Perez (1988) argue, technology was perceived as unidirectional process and it was considered that every nation should pass into the same stages of development. However, as initially depicted by Hobday (1995), technology is not unidirectional and some emerging technologies may provide latecomers to leapfrog in some kind of emerging industries and so, they need not invest in old technologies. This means a huge amount of saving in investment for the latecomer economies.

As we think Turkey as a country positioned behind the forerunners in the automotive industry; the definitions of catching-up and leapfrogging are significant. To know the existing paths and the technological level reached so far is utterly important for science, technology and innovation policies. We define catching up and leapfrogging mechanisms by benefiting from the studies of several scholars as follows.

In order to understand catching up and leapfrogging, we need to look at the basic view of technological development process. Accordingly, Dosi (1982) stated that the accumulation of practical and theoretical knowledge plays a key role in development phase of any technology. As mentioned above, Perez (1988) described the linear development of technology in this latter respect by revealing it as a unidirectional process. Technological development can simply be schematized as in Figure 3.

At the top, Figure 3 reflects the normal path of technological development. Hence, how can catching up and leapfrogging be defined? These definitions are described on this representation of normal development and are also presented in Figure 3.

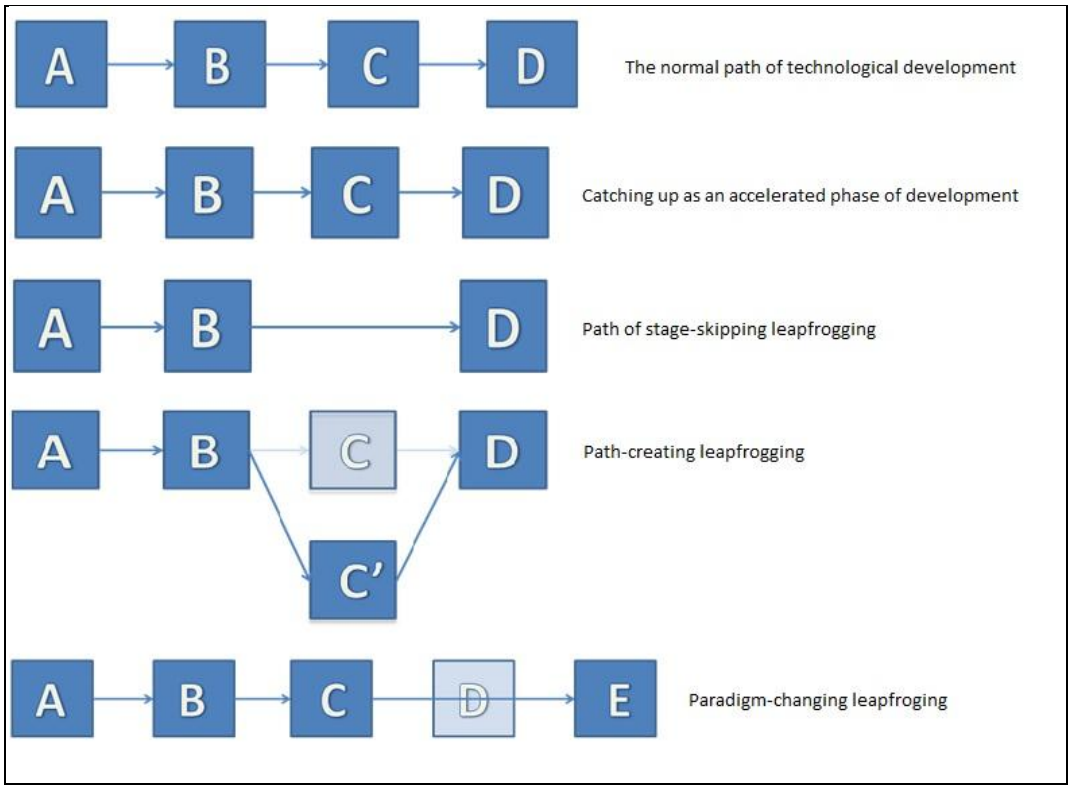

Figure 3 Catching up and several types of leapfrogging (Source: Wang and Kimble, 2011, pp. 314-315)

2.2.1. Catching Up

Catching up is the process of following the forerunners in the path of the unidirectional technological and economic development, but in an accelerated pace. The sub-processes that are very helpful in this process are referred to as technology transfer processes (Wang and Kimble, 2011, pp. 314-315).

Lee and Lim (2001, p. 426) defines this process as the "...latecomer firms follow the same path as that taken by the forerunners. However, the latecomer firms go along the path in a shorter period of time".

As mentioned, Wang and Kimble (2011) defines catching up process as it is based on the concept of technology transfer in general, but the central question is whether it is simply enough to attach it to the process of technology transfer, in particular. Those scholars answer this question by giving reference to other studies. The Foreing Direct Investment (FDI, Peri and Urban, 2006) and on the nation's ability

to learn (absorptive capacity, Cohen and Levinthal, 1990) appears to be two other important factors that affect the former. All these factors indicate the effectiveness and the speed of catching up.

2.2.2. Leapfrogging

Leapfrogging is characterized by altering the path in unidirectional way of technological development without undergoing same stages or phases followed by forerunners or finding a new path that is accelerating the follower in comparison. In some cases, followers might offer a brand new path that is completely changing the rules of the game and so, they might pass the forerunners which may lose ground in terms of competitive advantage by their huge investment on technologies that has become obsolete by this brand new path proposed by the follower. Steinmuller (2001, p. 194) describes leapfrogging as follows:

> *(...) bypassing stages in capability building or investment through which countries were previously required to pass during the process of economic development (Wang and Kimble, 2013, p. 7).*

Lee and Lim (2001) identified three separate leapfrogging models. "Path-following leapfrogging" is the same as our definition of catching up described above and it refers to follow the same path taken by the forerunners, but in a more accelerated pace. However, in the continuation of the same study proposed by the authors, more sophisticated types of leapfrogging; namely “stage-skipping leapfrogging” and “path-creating leapfrogging”, are discussed as two different kinds of leapfrogging within the framework of this study. In addition, as the last but the most promising type for the performer is called as “paradigm-changing leapfrogging” which was proposed by Wang and Kimble (2011) by taking advantage of the studies of the scholars; Lee and Lim (2001) and Gallagher (2006).

2.2.2.1. Stage-skipping leapfrogging

This leapfrogging model appears to be the model most frequently cited in the literature (Fan, 2006; Mu and Lee, 2005; Wei et al., 2005). As explained by the model, time spent on the path by the country is shortened by by-passing a stage in the unidirectional stages of technological development (Figure 3). Wing and

Kimble (2011), based on the reference to Soete's (1985) example of steam power, put forward that stage-skipping leapfrogging is still significant and valid in some cases, but it is not appropriate in some obsolete technologies that completed its normal cycle.

2.2.2.2. Path-creating leapfrogging

With respect to the previous model, path-creating leapfrogging requires more and more technological capabilities to realize. In this model, the country or company discovers a new path of technological development and alternative ways to capture the old technologies while making an investment in new technologies and in some cases, even it creates her own chances of passing forerunners by benefiting from them (Lee and Lim, 2001; Wang and Kimble, 2011, p. 316) (Figure 3).

2.2.2.3. Paradigm-changing leapfrogging

Paradigm-changing leapfrogging proposed by Wang and Kimble (2011) is based on the arguments of Gallagher (2006) and Lee and Lim's (2001) models of technological development. Gallagher (2006, p. 384) defined two separate forms as follows: "(...) (1) leapfrogging by skipping over generations of technologies; and (2) not only skipping over generations, but also leaping further ahead to become the technological leader" (Wang and Kimble 2011, p. 316).

Wang and Kimble (2011) comments that Gallagher's definition (1) resembles as stage skipping, and definition (2) as path-creating leapfrogging. However, consistent with them, this is likely to be available with a different form. Therefore;

> *(...) If a nation can, clearly and unambiguously, leap ahead of the existing technology as opposed to simply sidestepping a stage in the normal development, then in doing so it will, in effect, create a new technological paradigm (Wing and Kimble, 2011, p. 316).*

Consequently, catching up and stage-skipping leapfrogging represent the status quo while path-creating leapfrogging describes the competitive advantage. Paradigm-changing leapfrogging is not just competitive advantage, but it also means that rules are to be rewrittenin the field of technological development. This is also

related with thebusiness literature in which Bower and Christensen (1995) and Christensen (1997) put forward the concept of "disruptive innovation" and Charitou and Markides (2003) propose the term "disruptive strategy". Wang and Kimble (2013) concludes by identifying this paradigm shift that prompts "disruptive technology" as given below:

> *A disruptive technology disrupts a market by introducing a new, and often unlooked for, value proposition. At first, the potential of such technologies appears limited; however, as the technology develops, it begins to meet the needs of mainstream customers. At this point, the incumbent firms find they are unable to compete against the new value proposition and lose their position as market leaders (Wang ve Kimble 2013, p.7).*

The firm or country that carried such a leapfrogging is corrupting the current situation and re-writing the rules of the game.

In relation to the definitions above, types and characteristics of technological development can be outlined as given in Table 1.

2.2.3. Determinants of technological development

The explanations above have roughly outlined the case of technological development. One might surely propose that technological development has wide array of determinants and many different conditions featured by industrial or sectoral structure, geographical proximity and conditions, institutional setting, knowledge creation, absorptive capacity, export tendencies, market conditions etc. might affect the technological development path a country or a firm pursues.

Table 1 The features of technological development paths

Path of technological development	**Requirements**				**Outcome for the performer**
	Type of knowledge	**Level of Innovation**	**Absorptive capacity**[2]	**Conceptual gap to fill**	
Catching up	Minimal	Same with forerunner	Required to learn	No	Coming to the same level with the forerunner
Stage-skipping leapfrog	Minimal for an existing technology/little bit greater for a new technology	Same with the forerunner	Required to implement	No	Coming to the same level with the forerunner
Path-Creating Leapfrogging	Greater for both understanding the old technology and creating a new one	Same or somewhat greater than the forerunner	Required to develop something new and unique	Present	Coming to the same level with the forerunner or go ahead of it with competitive advantage
Paradigm-Changing Leapfrogging	Much greater to create a conceptual leap	Greater than the forerunner	Required to develop something new and unique	Present	Go ahead of the forerunner with disruption, competitive advantage and finally new rules established.

(Source: The table is outlined from Lee and Lim (2001), Wang and Kimble (2011, 2013).

For example, in their paper, Lee and Lim (2001) ask "(...) what are the conditions of catching up by latecomer firms where catching up[3] is measured in terms of both 'technological capabilities' and 'market shares'" (Lee and Lim 2001, p. 461). In their point of view, technological capabilities and market shares are not identical and not often represent the same line of development. Increasing market share does not mean increased technological capabilities as the country may import technology intensive parts by combining cheap labour and consequently may

[2]Absorptive capacity=social and technological infrastructure to be adapted (Cohen and Levinthal, 1990)

[3]For the term catching up, Lee and Lim (2001) refers catching up and the first two types of leapfrogging.

advance its market position. Lee and Lim (2001) argue that sustainable increase in the market share should be accompanied by advancement in concerning technologies in that industry. In case of Korean firms, as well as Turkish firms, technological development started with reverse engineering, imitation and assembly (especially in automotive production). In the second phase, they started to produce and develop low-tech and then high-tech parts. Afterwards, they learned to modify existing parts and they subsequently passed to the phase of new product concept development. Based on the study of L. Kim (1997), this process can be linearly outlined as duplicative imitation, creative imitation and innovation as well as assembly, low-tech part development, high-tech part development, product design and at last product concept creation.

Lee and Lim (2001) have made two central assumptions for their model. First, in their model, "(...) the technological capability of the firms is determined as an outcome of interaction of the available R&D resources and the amount of R&D effort (or technological effort)" (p. 462). The second one is that they are separating actual development of target products and their marketability. This means that they are separating invention from innovation and they are adding the probability of a developed product not to be commercialized. In the light of given assumptions, they have drawn a model as shown in Figure 4.

In their model, Lee and Lim (2001) has taken into consideration the expected changes for product development, market success, firms strategies and role of government as the main determinants of R&D effort which is the driver of R&D outcome and new knowledge creation. These outputs and new knowledge might possibly be combined with market success as the thriving model of technological and market catch-up.

Figure 4 Model of technological and market catch-up (Lee and Lim, 2001, p. 463).

The nature of the concerning technology is also worth mentioning. Breschi et al. (2000) argue that the nature of technology determines the technological regime, which is the outcome of innovative activities in a technological sector. Technological regimes are described by combination of technological opportunities, appropriability of innovations, cumulativeness of technical advances and the property of knowledge base (Lee and Lim, 2001; Breschi et al., 2000). Lee and Lim (2001) add up two new elements, namely technological trajectory and access to external knowledge base, to this description so that they might explain the process of catching up. In the model, expected changes for product development are constituted by not only frequency of innovation; but also fluidity of technical trajectory and access to external knowledge base. In a technical trajectory, *fluidity* refers the possibility of change in technological path. When fluidity is higher, there is less probability to predict future developments in that industry. *Frequency of innovation* means the possible quantity of new innovations that might emerge in a

selected timeframe. If the industry is prone to new innovations, it is likely to have these innovations frequently. For market success, typical factors of competitive advantages such as cost, differentiation and first mover advantage play role.

By building up this model, Lee and Lim (2001) explain the process of technological development in six industries in Korea including automotive industry. They also hypothesisethat:

> *(...) the less frequent the product innovation and the more predictable the technological trajectory are, the more-likely is catching up to occur when there is somehow an access to the existing external knowledge base to be combined with indigenous knowledge base of catching up firms (Lee and Lim 2001, p.464).*

In brief, different factors draw different paths for catching up and leapfrogging because every industry and every country has its own and unique conditions. One final note is that paths might be mixed up for some industries and some countries experienceno certain and rigid path of development in reality.

2.2.4. Examples of technological development in automotive industry

Concerning the fact that our focus is the automotive industry, here, we briefly emphasize the findings about automotive industry in order to outline the industry specific features in the path of technological development. In the study of Lee and Lim (2001) about Korean Automotive Industry, a framework is drawnin which global automotive industry is operating by using the Pavitt's (1984) classification. In line with this, automotive industry is scale-intensive and it is less science-based than electronics. The technological trajectory is more predictable and innovation is less frequent. Tacit knowledge is more important than other industries since each automobile component is more reliant on the body of a selected model or type. For each component, it is more complicated to form a global market. As a consequence, this has set great opportunities to the low-risk and clear target strategies of automobile firms.Firms might mobilize enormous R&D resources to these technological development strategies as, for instance, Hyundai Motors in Korea

did. Given that the technological predictability is present, huge amount of money could be devoted to these kinds of projects. With the full commitment of its board, Hyundai succeeded in stage-skipping development in engines. They first changed their engine plant by establishing a brand new R&D centre in Mabuk-li. As Nonaka (1988) proposed, this was "unlearning" process and Hyundai avoided carburettor-based engine, which was standard in that time. For the development of new technology, they also overcame the difficulties emerged by technological nationalism; found technology consulting firms that had the external knowledge they needed. Outlined factors were in favour of Hyundai's investment efforts and with the help of a clear technological trajectory, they had been certain about the next generation of engines concerning electronic injection. Hyundai invested on this technology, and developed it in its brand new plant by neglecting old fashioned style of thinking. Lee and Lim (2001) claimed about that;

> *(...) Hyundai was able to reduce the gap in engine technology in a very short period of time. Now technological capability of the Korean firms represented by Hyundai can be said to have reached the stage of product design in terms of the states of reverse engineering. For up to middle-sized passenger cars the localization ratio is higher than 90%, although core parts for luxury cars are still imported (Lee and Lim 2001, p. 470).*

This is an example of stage-skipping leapfrogging[4] given that Hyundai passed a step towards to the next generation of engine technology, namely injection-based engine (L. Kim, 1997; Lee and Lim, 2001).

Some further examples come from Wang and Kimble (2013). In their study on Chinese automotive Industry, they are sampling different kinds of leapfrogging as follows. Initially, they argue that in electric vehicles (EVs), BYD, a Chinese firm on electrical batteries, might go ahead of its competitors by developing LiFePO4 based batteries which increase the range of EVs up to 300 kilometres with a maximum speed of 140 kilometres per hour. If this is facilitated by global regulations imposed by the Chinese government, BYD might succeed in stage-

[4]In their model, Lee and Lim called this process as stage-skipping catching up.

skipping leapfrogging by eliminating their competitors. These scholars also claimed that BYD has chance to impose open-modular architecture of EVs rather than Western type of closed integral approach[5]. By merging this with successful business model, China could find an alternative route for EVs. This is an example of path-creating leapfrogging. In the end, they give the example of Shifeng which is a company operating in light and small electric vehicles (LSEV). Based on the term of disruptive technology stemmed from Bower and Christensen (1995), Shifeng design of LSEV for rural areas could be a dominant design in that class of EVs with their much lower cost, fuel consumption and huge market for rural people in China. By combining this with regulations, China could achieve a paradigm-changing leapfrogging in global automotive industry.

To conclude, industrial catching up and leapfrogging is a long standing debate however, there is a rising consensus on List's approach that some protective measures should be implemented for infant industries. Technological development is not only about accessing external knowledge. Latecomer firms should firstly benefit from it; however, for further development they should absorb and then, create new knowledge using transferred knowledge by developing and designing their own concepts. There are different types of catching up and leapfrogging based on the different and wide array of factors related to specific industry and country. The technological trajectory, innovation frequency, market success, government's role and policies as a whole have a potential to affect the types of technological development. In order to catch up in a selected industry, one should pay attention to all these factors in a holistic manner and should build up the policies accordingly.

Here, another central question is what are the tools that may be utilized to achieve technological development. This question carries our debate on R&D and innovation on the micro basis that must be managed and accomplished by firms

[5]Chinese development of electrical vehicles is based on a modular approach which makes the industry similar to the highly open architectural structure of ICT. Western producers, in contrast, uses closed integral approach and there is no possibility of being modular for different parts of electric engine which are produced by different manufacturers. Fostered by its huge market, this gives an opportunity to Chinese manufacturers to win the competition for dominant design in electrical vehicles.

and industries as a whole. R&D and innovation may be considered as tools that are capable of providing industrial and technological development for the effective performers. In the subsequent section, we will deeply explore these terms.

2.3. Tools for technological development: R&D and innovation

As the globalization has expanded throughout the world; besides labour, capital or resources; attaining knowledge has gained significance to gain competitiveness for both firms and nations. In industry, knowledge creation processes are mainly dependent upon research and development efforts sustaining within the firms by interacting outside environment and different agents. Those efforts can be harmonised with innovation and then, general approach assumes that innovation, mostly sourced by R&D activities, provides competitiveness for both firms and nations.

2.3.1. Defining R&D and innovation

Frascati and Oslo Manuals[6] are widely accepted as the main sources of definitions for both R&D and innovation, respectively. Frascati Manual defines *research and development (R&D)* as follows;

> *Research and experimental development (R&D) comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications (OECD, 2002, p. 30).*

And Oslo Manual defines *innovation* as;

> *An **innovation** is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations (OECD, 2005, p. 47).*

[6]The manuals are valid while evaluating project proposals in Turkey. These manuals are also used as the official sources of project evaluation criteria by R&D funding institutions such as TUBITAK (The Scientific and Technological Research Council of Turkey) and TTGV (Technology Development Foundation of Turkey).

And, for the *types of innovation*, the manual makes the following distinction;

> - *If the innovation involves new or significantly improved characteristics of the service offered to customers, it is a product innovation.*
> - *If the innovation involves new or significantly improved methods, equipment and/or skills used to perform the service, it is a process innovation.*
> - *If the innovation involves significant improvements in both the characteristics of the service offered and in the methods, equipment and/or skills used to perform the service, it is both a product and a process innovation (OECD, 2005, p. 53).*

Of course, the definitions taken from OECD have been provided by research and it took literally decades for these definitions to form. Given that they are evolutionary concepts, their definitions are also evolving, even today, by new findings and approaches. Here, it is better to give a brief summary of how the term "innovation" has evolved through history.

As Rosenberg (1986) stated, at first, innovation was perceived as "blackbox", and for technological innovation, as "a system containing unknown components and processes" in economics profession. Innovation might be a new product, the substitution of a cheaper material, the reorganization of production and an improvement in instruments and methods of doing innovation (Rosenberg, 1986). Since World War II, the conventional view of innovation had beenthe so-called Linear Model that suggests that innovation starts by research and development and continueswith production and marketing. There was no assumed feedback loops among these phases.

On the contrary, Rosenberg and Kline (1986) offer Chain-Linked Model in which all market signals, research, development, design and redesign phases are interacting with each other and feedback loops help them reduce uncertainty inherited by innovation. Dosi (1988, p. 1125) suggest the term 'innovation' in a broader perspective and he argued that "in non-centrally planned economies, new process and product innovations come from the interactions between a) capabilities and stimuli generated within each firm and within each industries b) broader causes

external to the individual industries". Some of the broader causes he referred is "(...) state of science in different branches, the facilities for the communication of knowledge, the supply of technical capabilities, skills and engineers, market conditions, macroeconomic trends and public policies" (Dosi, 1988; p. 1126). Dosi also emphasize the importance of learning-by-using and learning-by-doing in the innovation process. Besides, Rothwell (1992) stresses the value of networking among firms and suggests that innovation is becoming a multi-firm networking process. Rothwell also brings up the involvement of major and minor technological advances in innovation and sees commercialization as necessity in the innovation process. As convenient, in fact, technological advances are generally referred only as invention unless it is commercialized.

However, in contrast to neo-classical thought, a new stream of thought flourished, emphasizing innovation could be best understood as a socially embedded phenomenon which canbestbe analysed in a systemic way. Freeman (1982a) proposed the term of 'National Innovation System' (NIS) by being inspired by List's seminal book, namely "The Political Economy of National Systems" (1841). In his book, List strongly advocated the role of state in industrial catching up process. Parallel to this view, in contemporary economies, Freeman also challenged Washington Consensus[7], giving a stronger emphasis on government policy for catching-up economies (Lundvall, 2004). Just as List gave central role to people, organizations and competence building[8]; firstly Freeman, and then Lundvall, put interactive learning central at the core of their analysis. As an evolutionary approach, NIS gives strategic role to knowledge and learning. However, this is not sufficient; learning and innovation capabilities are perceived as "not only a question of education and research but also broad set of institutions enhancing

[7] The term **Washington Consensus** was coined in 1989 by the economist John Williamson to describe a set of ten relatively specific economic policy prescriptions for the developing countries in crisis. Washington, D.C.-based institutions such as the International Monetary Fund (IMF), World Bank, and the US Treasury Department were assigned to implement these prescriptions in order to improve the economies of countries in crisis. The prescriptions involved policies in such areas as macroeconomic stabilization, economic opening with respect to both trade and investment, and the expansion of market forces within the domestic economy.

[8] List called people and organizations with capabilities and skills as "productive forces" (List, 1841).

learning" (Lundvall, 2004). Consequently, innovation emerges as a social process constituted by interaction of different agents in an institutional setting which is also affected by history, culture, geography, society etc.

Nevertheless, NIS is not an approach that is able to correctly explain the situation of developing countries. As an ex-ante view, List insiststhat in catching up countries and developing regions, system construction and system promotion should be at the focus of development. Lundvall (2004) emphasizes that NIS approach is an ex-post view, explaining the case of developed countries; not the developing ones. NIS still does not include the power aspects of development. Then, it seems as a requirement to adopt NIS as suitable for developing countries. For example, as an attempt, Lall and Pietrobelli (2003) proposed "national technological system" for less developed countries.

From this very brief history of the concept of innovation, it is seen that the scope of this concept is getting broader and broader as the literature expands. In black box model, it was initially assumed that it was realized within the firms with isolation; but now, it is subsequently perceived as an interactive process in which many agents in the system may affect, direct, regulate or perform it. Furthermore, automotive industry has given invaluable insights by fostering this understanding of innovation. In their seminal book, Womack et al. (1990) is explicitly explaining how Japan Auto Industry succeeded in catching up with Europe and the USA and besides, all other reasons, the interactive approach between agents proposed by the Japaneseindustry has played a vital role in this process. The interplay between Japanese OEMs and suppliers, their industrial organization based on trust and collaboration has boosted the country's industrial performance not only in automotive but also in other related industries. The innovation is taking place not solely in OEMs that share knowledge to enhance R&D capabilities of their committed and trustable suppliers; but this knowledge sharing is improving the innovative performance of the suppliers as well. The improvement in the performance of suppliers is strongly contributed to the performance of OEMsand thus, this has enable to outperform their counterparts in the west.Briefly, in the

automotive industry, the collaboration for R&D among OEMs and suppliers has been in action long time ago. In the past, automotive firms have changed their organizational structure to adapt this interactive manner of business.

One final note is to state that throughout the thesis we are using the definitions of the Frascati and Oslo manuals concerning R&D and innovation, respectively. There are two reasons for this:

1) Our case studies are highly related to these definitions since the evaluations on R&D projects have been made under these definitions by R&D fund providing institutions in Turkey. These definitions are also incorporated in the methodology part, questionnaires etc. so in the rest of the dissertation, innovation and R&D concepts refer to OECD definitions.

2) These definitions are commonly used in the literature and the international R&D institutions.

If these concepts are of utmost importance for the development of nations how can policy makers support R&D and innovation performers? What is the rationale for government intervention on these issues? In the following sub-part of this section, we briefly review the literature to address these questions.

2.3.2. Rational for government intervention on R&D and innovation

In this sub-part of the thesis, we initially explain the rationales for government intervention. The economic rationales can be classified under two main theoretical background; namely market failure in the neo-classical approach and systems failure in the systems of innovation approach. We, then, state the types of intervention that governments use to direct performers towards R&D activities in order to enhance our understanding under two somewhat different theoretical frameworks. We offer a comparison among R&D grants and R&D loans to discern differences in these different types of government intervention so tomake our conclusions in more concrete manner. We begin by market failure argumentbecause measures for systemic failure are more complex and sometimes

they involve the measures proposed by the market failure argument but in a more detailed way. This theoretical discussion might be, furthermore, perceived as a transition of economic thought pursued through the historical evolution of the economy and technology policy.

2.3.2.1. Market failure and rationale for government intervention on R&D and innovation

In neo-classical economics, it is supposed that the government does not intervene in the markets and let the "invisible hand" allocate resources in an efficient way. Optimal resource allocation refers equilibrium in the markets. To have equilibrium, markets should sustain three prerequisites:

1) Perfect information (every agent in the market should be fully informed about new products and processes)
2) Perfect competition (every agent in the market has rivals to compete with and each sector is characterized by competition)
3) Profit maximization (agents performing with the aim of maximizing profits)

Neo-classical scholars assume that economy grow by additional investment in capital and by increasing the labour force under these assumptions. This predominant idea was ever first shaken by the debate about the central drivers of the neo-classical economics. Investment and increase in labour force was proposed as the central drivers of economic growth.Abramovitz (1956) and Solow (1957) pioneered this view, however, with a backdoor arguing that what is not explained by these factors can be labelled as technical change or knowledge accumulation. This means that various factors can affect the markets and markets subsequently may fail; they could lose their efficiency since the assumptions are too strong in a real market setting. Nelson (1959) was the first scholar who point to the market failure argument especially in terms of basic research activities that take place in universities:

> *(…) when the marginal value of a "good" to society exceeds the marginal value of the good to the individual who pays for it, the allocation of resources*

> *that maximizes private profits will not be optimal. For in these cases, private profit opportunities do not adequately reflect social benefit, and in the absence of positive public policy, the competitive economy will tend to spend less on that good "than it should". Therefore, it is in the interest of society collectively to support production of that good (Nelson, 1959, p. 298).*

In this context, Nelson (1959) argues that technological knowledge and technology products are not subject to the characteristics of a normal good in terms of neo-classical economics. As the markets fail, resources are not optimally allocated and the government intervention becomes necessary in order to compensate private returns on R&D investment. Unless it is supported, there might be an underinvestment problem for the production of knowledge, thus innovative goods. It is expected that the interventions would generate technological knowledge and innovative technologies for economic growth (Arrow, 1962).

Neo-classical scholars narrowed down the concept of innovation to research and invention. They did not distinguish information and knowledge; they simply equated them. Information and knowledge as well, are codified, generic, accessible and easily adoptable by every agent. The transformation from research to product and process is a "black-box". As a result, technology is exogenous to economic growth.

In contrast to this neo-classical understanding for knowledge, Nelson (1959) and Arrow (1962) had altered the term of scientific knowledge. Rather than neo-classical information, scientific knowledge has;

1) uncertainty (its outcomes are uncertain)
2) inappropriability (performer cannot fully appropriate the benefits)
3) indivisibility (a minimum investment on knowledge before creation)

The result triggered by these features of scientific knowledge is simple: underinvestment in R&D activities. Mainstream economics see this as the main rationale for government intervention. The aim of the intervention is to create optimal resource allocation to research and development to in a sense push

underperforming agents to an optimal level. Neo-classical assumptions justify intervention especially to the areas such as energy, large-scale science and technology projects, defence research etc. where optimal resource allocation is hard to accomplish. On the technology policy side, market failure arguments provide a basis for government intervention in free-market economies but it is limited in the perspective of the provision of private returns to R&D performers.

However, the debate was not over and additional insights were proposed by Kendrick (1961) and Denison (1962) who emphasize the uneven distribution of productivity growth throughout the sectors. As described subsequently, Nelson and Winter (1977) used this as a relevant argument for proposing innovation policy by implying that targeted industrial policy making is a necessity. Moreover, Gerschenkron (1962) pointed out that since technology is not a public good; it refers that narrowing down the differences in technology among rich and poor countries is not an easy task to accomplish, requiringnot only technological but also institutional change. This was an appeal to call government for a more proactive role in the economy.

Despite this progress of understanding in mainstream economics, throughout 1960s and 1970s, technological change was still largely perceived as exogenous to economic growth. However, the crisis of the 1970s and the rising competitive challenge of the 1980s had changed this and as Artis et al. (1997) describe; after 1980, a renewed interest on technological change emerged. Technology had begun to be described as the source of growth and employment (Schreiber, 1967; Vogel, 1979; Thurow, 1980). The main outcome was that, as expected, technology and mercantilism debate reopened.

As those underpinnings in mind, the neo-classical theory had been extended its sight by the additional arguments of the new growth theory. Krugman (1979; 1986) and Romer (1986) exposed that technology is endogenous rather than exogenous to economic growth. This was an additional assignment for the government intervention to target selected industries as proposed ealier by Kendrick (1961) and

Denison (1962). In comparison to neo-classical approach, new growth theory has been distinguished by emphasizing three aspects of R&D:

1) Certain degree of randomness on R&D (it refers no perfect information)
2) The importance for growth of technology flows between agents
3) The importance of technology and innovation policy for growth.

The progress of neo-classical arguments is still under criticism. This criticism is firstly focused on the degree of uncertainty in the innovation process. As Bach and Matt (2005) stated innovation has much high uncertainty that was accepted by the new growth theory. In addition, the relationship between R&D and growth is linear and too simple to conceptualize real world cases (Verspagen, 2005). Finally, the assumption of equilibrium in such a process like innovation is not relevant.

To conclude, there are certain problems that still have not been solved by the mainstream economics in terms of R&D and innovation. As a matter of fact, knowledge can spillover from its origin and capable agents can benefit from this mostly free good (Cohen and Levinthal 1989, 1990; Ebersberger 2005). This can trigger appropriability problems for the creator of knowledge, and creators cannot entirely appropriate their innovations because there are imitators in the market. Dissemination of knowledge is, however, not the sole problem and for innovative projects, there can be sunk costs which fosters the problem of underinvestment, given that it creates a strong barrier to entry. To clarify, innovations inherently involve risks and uncertainty; there is no guarantee for success. In this case, financial markets are more prone to invest less on that kind of risky projects and uncertain outcomes; and then, an underinvestment problem may occur. Besides, some projects such as big science projects might require huge investment which cannot be compensated by an individual firm. Even if there is sufficient capital in the market, the investment required might be more than the amount a potential performer is willing to take. These underpinnings, therefore, constitute the basis for governmental intervention using the arguments of the market failure approach. As mentioned by Hauknes and Nordgren (1999), the fulfillment of governmental and

public needs related to health, environment and defense maintain the justificationof government intervention on R&D. Blankart (2005) added up this debate a valuable insight that why government indeed intervene might be discerned by "analyzing the political sphere and the decision-making process within the government and its bodies" (Ebersberger, p. 30).

Before we carry on this debate by fostering it with the arguments of systems of innovation approach, we briefly analyze how governments intervene to the marketsunder the neo-classical market failure approach.

2.3.2.2. Types of government intervention on R&D and innovation in terms of market failures

In mainstream economics, governments intervene mainly in three ways to boost technological activity, research and development (R&D), invention and innovation. These policy tools are performing R&D directly (publicly funded R&D); giving R&D supports (grants and loans) and providing tax incentives (Özçelik and Taymaz, 2008). There are direct and indirect effects of these supports on the firm performance. The direct effect is that the total R&D expenditures of firmsincrease (holding firm financed part of R&D expenditure constant) while indirect effects come from how firms will react to this policy (will the firm change its behaviour?). Firms' response can be in two ways: the first one is that company might augment its R&D expenditure in response to R&D support (thus increase own private spending) or the company may displace the supported amount with its own private R&D fund (thus the private R&D expenditures are crowded out). Of course, the former is better for knowledge production and productivity and in the context of what is aimed by the intervention. Furthermore, there are some other benefits of R&D supports. They might lower the private cost of R&D and turn an unprofitable project into a profitable one; it may speed up an ongoing project or upgrade research facilities in such a way that further R&D projects might be afforded with lower costs. Firms might also gain know-how and learning capabilities while performing R&D activities (Özçelik and Taymaz, 2008).

R&D Grants vs. R&D Loans

To our knowledge, studies concerning R&D supports in the market failure approach are predominantlyon R&D grants and tax incentives; however, R&D loans have taken little attention. The studies concentrated on loans are particularly towards credits provided by banks and mutual guarantee consortiums which are very common especially in Europe (Ughetto and Vezzulli, 2008). Myers and Majluf (1984) highlighted limited capability of banks in sustaining investments in innovation and mutual-guarantee consortiums can assess the R&D activity in a better way, representing easier financial opportunities, particularly for Small and Medium-sized Enterprises (SMEs). In general, investors are hindered by several reasons such as risk aversion, moral hazard problems, internal capital constraints and information asymmetries (Myers and Majluf,1984; Leland and Pyle,1987; Bhattacharya and Ritter,1983; Boocock and Woods,1987; Bougheas,2004) and it blocks the further investment on R&D. Moreover, it is widely accepted in the literature that SMEs have more financial constraints on performing R&D and their opportunities to reach capital is more limited with respect to larger firms and incumbents. This case is more evident in developing countries where investment, venture capital opportunities and public equity markets are lagging (Hall, 2002). This is the reason behind why SMEs require easier ways to reach finance in order to perform R&D. With the supports, it is subsequently expected that the propensity to innovate in small firms increases relatively more with respect to larger ones as argued by Lach (2002), Özçelik and Taymaz (2008), Busom (2000) and this case is particularly the same for high-tech firms (Carpenter and Petersen, 2002). Further support comes to this argument from Himmelberg and Petersen (2001), arguing that

> *the principle determinant of investment for small and high tech firms is internal finance and (…) large firms are unlikely to face significant internal financial constraints because they have better access to external finance and generate cash flows in excess of investment needs (Himmelberg and Petersen, 2001; p. 42).*

To take one step further, there may be country-based determinants embedded to the institutional setting. Hoshi et al. (1991), for instance, portray the strong ties of Japanese firms with banks and their propensity to use external funds to innovate. In contrast, Hall (1998) suggests that by using emprical evidence, stock of liquid assets is a major source of R&D in the United States. These two contradictory views put forward the dependence of decision taken by small, high-tech firms on wide array of different conditions and settings. In line with this argument, Bougheas (2004) argues that small firms in Canada, United Kingdom and United States are making more use of internal finance as they perform R&D whereas small firms in Japan, France and Germany innovate mainly by using external finance.

In case of R&D grants, Lach (2002) observe that the requirement of small firms is much more evident and large firms are generally performing R&D projects even if they would not have been subsidized. He further argues that subsidized money is more effective by allocating it to small firms in terms of R&D activity and he comes to the conclusion that R&D subsidies should be directed towards them. In their study based on the data taken from Turkish R&D grants and loans, Özçelik and Taymaz (2008) claim that subsidies are taking more effective role in late industrialization and this effect diminishes as the the intensity of R&D activities increase. In contrast to Wallsten (2000), Lach (2002), Hanel (2003), they further put forward that there is no validation of the hypothesis proving the tendency of larger firms benefiting more from R&D supports in the case of Turkish R&D performers. Özçelik and Taymaz (2008) subsequently conclude that there are positive effects of both R&D grants and loans on R&D activities performed in Turkey. Given this argument, we can deliberately put forward that R&D loans in Turkey has increased private spending on R&D activities in view of the fact that beneficiary firms are obliged to pay back the subsidized amount.

In conclusion, one can claim that R&D supports are beneficial for small and high-tech firms by fostering the innovative capabilities of them. Support mechanisms also target towards market failures that prevent optimal resource allocation to technological development and scientific research. In this perspective, as a

developing country, R&D loans are of utmost importance for Turkey as we think of the fact that 98 % of Turkish industry is composed of SMEs that have difficulties in accessing to finance. Ever since TTGV is the sole loan provider as the automotive industry in Turkey was deepening; one can claim that it gives a relevant evidence to analyze TTGV data, as we do in this dissertation.In particular, until the R&D grants have intensified after 2008, TTGV secured its position on Turkish Innovation System as the only loan provider of Turkey. In the days of high inflation until 2002, TTGV supports were desirable to a great extent by the industrial firms.

After having examined government intervention in the perspective of mainstream economics, now, we are ready to proceed to government intervention under systemic failures which is more complex in nature.

2.3.2.3. Systemic failures and types of government intervention on R&D and innovation

It was, even though, added up some certain aspects of innovation and technological knowledge by the arguments of new growth theory; there was still much to overcome to understand innovation in market economies. The Systems of Innovation (SI) Approach was the one directing to explain innovation and technology policy under the assumptions of its understanding. Here, we first briefly describe innovation and its aspects so that we are able to explain systemic failures and technology policies under SI approach designed to overcome those failures for having better systemic outcomes of innovation.

Aspects of innovation in SI Approach and critics to market failure

Rooted from the evolutionary theory (Nelson and Winter, 1982), institutional approach (North, 1990) and sociology (Granovetter, 1985), SI approach emerged as a reaction to inadequacy of neo-classical economics on the innovation process (Lundvall, 1992). In contrast to mainstream economics, innovation, in the scope of SI approach, is differently perceived in many aspects. These can be summarized as:

1) Uncertainty: Innovation is a process of experimentation and discovery; thus, outcomes are uncertain. Firms sustain innovative activities so that they can be competitive over their rivals. However, it is also uncertain how rivals react to the innovative action of the performer. In some cases, it is possible for rivals to compete the first-mover by producing a brand new innovation superior to the first-mover's innovation. Innovator's success and rivals' reaction are both uncertain in this sense.
2) Necessity of new knowledge for innovation: To innovate, new knowledge (codified, tacit or both) is an indispensible necessity. As Gibbons et al. (1994) claim, firms are the sole knowledge producing agency in capitalism (Metcalfe, 2007)[9]. It simply means that firms should be fed up by new knowledge in different kinds to perform innovation so that capitalist modern economy sustains.
3) Embeddedness of innovation: Market and regulations are decisive in outcomes of innovation. As Metcalfe (2007) stated innovation policy is composed of competition policy and efficient markets policy; and distorted markets harm innovation processes. Innovation is embedded in a social, economic and institutional framework.
4) Tacitness of knowledge: SI approach claims that tacit elements of knowledge are also important for technical change. In parallel, it refers that idiosyncrasy, individuality and imagination are indispensible elements of innovation. Information required for innovation is "sticky" and does not flow easily among the agents. Knowledge is costly to create and diffuse.
5) Systemic nature of innovation:The most obvious characteristic of modern economics is the distributedness of innovation processes (Coombs et al.,2004); and SI approach commonly emphasize the systemic nature of innovation which is an intrinsic outcome of division of knowledge. Innovation systems are self organizinghowever, do not arise naturally. SI approach has been inspired by early writings of Young (1928) about

[9] Please note that Metcalfe (2007) defines firm in a broader meaning and put agencies like third sector, foundations, hospitals – the agents that are capable of making innovation without seeking profits, as in the definition of firm.

increasing roundaboutness of production – not solely material but also in terms of knowledge. As a matter of fact, increasing division of labour in knowledge production is accompanying with this distributedness in the innovation process. The distributedness refers to the fact that innovation is not performed in isolation; rather, it takes place with interaction among agents. In the SI approach, since there are no representative agent as in the neo-classical approach, heterogenous firms produce knowledge and innovation in a system characterized by interaction. The effective interaction among agents presupposes relationship between individuals built on trust and empathy.

6) Markets as essential elements of innovation systems: SI approach clearly discerns innovation systems from invention systems.[10] Innovation systems are located as a bridge between invention systems and market systems. Innovation systems are embedded in the market processes and are considered as the transition mechanism for commodification of knowledge which is produced in invention systems and is valued within market systems (Metcalfe, 2007).
7) Evolutionary nature of innovation processes: For innovation, asymmetric information is essential to provide novelty and variety which are important in evolutionary understanding. In parallel, evolutionary scholars also claim diversity creation and selection as engines of innovation. They, moreover, argue contingencies and specific historical circumstances, playing a larger role in innovation, and this is called as path dependency of innovation processes. These all generate a very different understanding with respect to mainstream economics where full information is necessary and competition rather than selection is a vital element of the market system.

[10] Metcalfe (2007) defines invention systems as a network of knowledge producing agents such as universities, research laboratories etc. Innovation systems are quite different and defined as a network of agents including knowledge producers - not solely universities but also firms and knowledge combinators like complementary agents and firms as well. Innovation systems are related to commodification of knowledge in the markets and thus, they are bridges between invention systems and market systems.

With those aspects in mind,SI approach can also be viewed as a heavy criticisim of how mainstream economics approach to innovation. Scholars claim that innovation process is intrinsic contrary to the main assumptions of the market systems based on perfect information and perfect competition. This claim could be briefly summarized as follows.

The very first question is why "market failure" approach is not sufficient to explain government intervention? SI scholars answer this by describing uncertainty and asymmetry as the driving force of competition. Firms have an intuition to search for new knowledge and innovations to compete withtheir rivals and to have market power. Competitive firms grow at the expense of their less competitive rivals. Metcalfe (2007) explains the contradiction behind market systems approach with the following arguments:

> *The idea of a perfectly competitive allocation of resources (the doctrine of Pareto optimality) is a distorting mirror in which to reflect the operation of restless capitalism. (...) capitalism and equilibrium are incompatible concepts; innovation and enterprise preclude equilibrium (Metcalfe, 2007; pp. 54-55).*

These arguments were, of course, rooted in and inspired by the earlier Schumpeterian concept of "creative destruction" (Schumpeter, 1942). Schumpeter describes imperfections as integral and necessary aspects of knowledge in a market economy where entrepreneurship has no meaning in an economic equilibrium of any kind. As Stiglitz (1994) points out innovation eliminates the possibility of perfect competition and innovation policy principles could not be in accordance with the perfectly competitive market models. Evolutionary competition is a dynamic discovery process involving innovative experiments. Thus, Pareto optimality is against innovation and the change in the dynamics of modern economic systems. Given these arguments, Metcalfe (2007) claims that market failure approach has nothing to do with the precise design of policy experiments and their appropriate method of implementation. Finally, he strikingly concludes that "the market failure, despite its formal elegance, is an empty box" (Metcalfe, 2007; p. 60).Chimanade and Edquist (2006) also emphasize the unbeneficial nature

of standard economic policy for fixing the problems related to innovation and R&D.

Systemic failures and government intervention in SI

We have just defined how SI scholars describe the aspects of innovation in modern economics and how they criticise mainstream economics regarding their perception of innovation. Here, the question to ask is how they define innovation systems? In the perspective of SI approach, system is composed of three indispensable elements including components, connections and placed boundaries. They assume that no interconnection indicates any system. Thus, interconnection between components is vital in this approach. The macroeconomic conditions, suitable economic climate, low interest rates and stable monetary conditions are prerequisites to have an effective ecosystem and SI policy. All these factors encourage investment decisions on R&D and innovation. As SI approach selectively emphasizes an institutionalized framework for innovation; market failure approach focuses solely on the expenditure on R&D. As we have mentioned, this is simply referring the complex nature of systems of innovation with respect to market system.

In this complex system of innovation, what are the sources of failures that impedeinnovation and how could a policy-maker deal with these systemic failures to fix the innovative ecosystem? At first, we should reply the question of why innovation systems may fail. As regarding the elements of the system, the functioning of a system might be broken up if there exist missing components, missing connections and misplaced boundaries. The general assumption is that different kinds of organizations (actors) interact over the institutions (rules of the game) and this collective interplay between actors under determined rules based on empathy and trust provides synergy to generate innovations. If there is a problem in or between the components, connections or boundaries of the system, the system does not function well to generate innovations. This is called "systemic problem (failure)[11]" and, in line with the SI approach, public intervention is necessary as the

[11] Both 'systemic failure' and 'systemic problem' are used in the literature. For example, Metcalfe (2007) prefers to use the word 'failure' while Edquist (1997) uses the word 'problem'. Edquist

system will underperformunless private actors solve the problems. SI approach sees innovation policy as a complementary to markets and public intervention should have additionality in this sense.

And what are the systemic problems a policy-maker might come across with? Chaminade and Edquist (2006) states possible systemic problems in an innovation system as such:

1) Infrastructure provision and investment problem
2) Transition problems related to technology change
3) Lock-in problems (path-dependency in a selected paradigm)
4) Hard and soft institutional problems
5) Network problems
6) Capability and learning problems
7) Unbalanced exploration-exploitation problems
8) Complementarity problems

In this respect, governments intervene SI in order to overcome these problems to provide and sustain efficacy of innovative actions within the system. SI approach claims that state should first develop its problem solving ability and policy-makersshould focus on adaptation while developing policies in a systemic perspective. Adaptation surely reflects the evolutionary nature of the approach. Policy intervention may face two main problems; namely, uncertainty and selectivity. The selection process is determined by the level of risk and uncertainty and when they are high, policy intervention is required. For achieving the right selection of policy mix, one should simply pose three simple questions to answer as a basis for policy development. Those are;

1) Why to intervene?
2) How to intervene?
3) What are the problems to address?

(1997) claims since there is no optimality in the SI approach it is better to use problem to define bottlenecks in innovation systems. In this dissertation ‘systemic problem’ and ‘systemic failure’ is being used interchangeably with the same meaning.

Of course, solely the answers to those questions do not determine the choice of policies. As Elg (2006) stated policy-making is not always rational and rationales may emerge ex-post. Also, ideology of the policy-maker, imitation of policy-models and some external factors such as lobbyism may affect the selection and design of innovation policies (Edquist and Chaminade, 2006). Nevertheless, with these factors in effect, as Norgren and Hauknes (1999) claims there are two options for basic choice of a policy-maker:

1) Strengthening the existing system
2) Facilitating the creation of a new system

Given these choices, factors and options in the selection process, policy-making is an individualistic process and its design and implementation is possible under these conditions.

For overcoming uncertainty, Smits and Kuhlmann (2004) describe two systemic instruments as following:

1) Supplying the information different actors need to define their strategies,
2) Providing the actors with the instruments, facilities and environments for experimenting and learning.

High uncertainty means high risks that impede the innovation process in the system. The instruments used below are aimed at lowering the uncertainty and related risks.

By combining the above choices in selection and uncertainty, as Steinmuller (2005) presents, we might group instituted technology and innovation policy under 4 themes and 12 policy designs. Here, it is necessary to explain them briefly to back up the policy conclusions in Chapter 7 both theoretically and practically.

1) Supply-side policies: Those kinds of policies for innovation define technology as a linear-process. They generally assume that upstream supply of technology triggers downstream innovation. There are five types of

supply-side policies: horizontal subsidies, thematic funding, signaling strategies, protectionist measures and financial policies. They might be briefly detailed as follows:

a) Horizontal subsidies: It involves tax credits and R&D subsidies. It is applicable to all firms (anyone can benefit) however, provokes self-selection problems. It has problems of opportunistic behaviour and might miss sectoral technological opportunities since it has no differentiation on the selection of firms. Thus, it also supports firms that have high level of R&D.
b) Thematic funding: It is the dominant design for supply-side measures widely addressed in the R&D funding schemes of the countries. It is applied by firstly predefining the themes, thus, takes the advantage of sectoral, regional and technological opportunities.The main disadvantage of this kind of funding is to narrow down the areas thus, it is likely thatnovel innovations are filtered outside the framework of the support.
c) Signalling strategies: The main aim of these measures is to influence technological expectations of private decision-makers. Large-scale education and training programs and specific funding of future technologies to support faster diffusion are examples to such policies. The former tool is too expensive to be employed sincethe policy tool should be flexible to be applicable todifferentkinds of agents and the latter has the risk of creating monopolies.
d) Protectionist measures: It mainly involves import substitutionpolicies which are now mostly restricted by international trade agreements. The main criticism directed to such measures is that itsboundary between mercantilism and industrial promotion is blurred.
e) Financial measures: Venture capital and initial public offerings (IPOs) are two main tools used under these measures. It is concerned with specific features of the sectors and can be assumed as an intermediary between horizontal and thematic funding policies.

2) Policies concerning designs for supply of complementary factors: These policies in the perspective of the SI approach aim at preventing bottlenecks in the systems, reducing costs and generating institutional change in the design of innovation system. The common tools for achieving these aims are increasing the capability of labour-supply by education and training with an interdisciplinary approach and technology acquisition. Technology acquisition is mainly related to intellectual property and monitoring balance of trade in technology licences.[12]
3) Demand-side designs: Such designs aim at reducing cost by learning and faster rate of adoption of new technologies and as a matter of fact, raising the awareness of some specific technologies. Subsidies for adopters and providing information to adopter by diffusion policies are two main tools that are used to influence adopters.
4) Policy designs for institutional change: Those designs utilize SI approach, as well as designs for complementary factors assuming innovation is systemic including multiple actors both from public and private sphere and in which elements of coordination are beyond price and market. Given its systemic nature, these kinds of designs are highly complex to implement and maintain. There three kinds of policy designs. The first one is about identification of the missing links and fixing them by assigning new missions to public institutions. The second is about creating complementary institutions to overcome information asymmetries. Finally, the last one is supporting cooperative research by treating technology as a quasi-public good. All these tools are composed of complex mixture of design and implementation.

Here, it is a necessity to note that there is no panacea in technology policy. The validation of policy designs and classifications in term of different settings (for example different countries) is an ongoing debate started from Ergas (1987) who grouped countries as ‘mission-oriented countries’ and ‘diffusion-oriented’ in terms of their implementation of technology policy. Of course there are many other

[12]For details, please see Japanese example on this issue in Steinmuller (2005).

different mixed designs that can be considered but due to space limits we refer the reader to Steinmuller (2010).

In this section we briefly discussed the rationale for government policy with specific reference to science, technology and innovation policy. We will benefit from this discussion about government intervention on R&D, particularly in Chapter 7. The framework discussed in this section will be used to offer specific policies for the Turkish Automotive Industry based on the results of Chapters 4, 5 and 6. Detailed investigation of the TTGV R&D supports, firm visits and expert opinions will help us to make conlusions on the main bottlenecks in technology development in the automotive industry. These remarks together with the policy framework we discussed above would help us to propose specific policies that we think would address the main problems in technology development in the automotive industry.

In the next section, we briefly review current literature about Turkish Automotive Industry to widen the context of our understanding.

2.4. Current position of the Turkish Automotive Industry

In the wide array of the literature about the automotive industry, there are many studies related tothe position of Turkish automotive industry. In this section, we briefly group and reviewthe literature with specific reference to our main topic on the intersection of our core terms, leapfrogging, R&D funding, government intervention and Turkish Automotive Industry. At first, we begin by explaining the main arguments of the literature in a few words and then, establish a connection between our core terms by focusing on the findings they provide in order to assist the main investigation in the following chapter.

As we consider the literature concerning Turkish Automotive Industry, we find that the discussion topics are concentrating on buyer-supplier relationship, technology or knowledge transfer, foreign direct investment and competitiveness of local incentives and suppliers in Turkish Automotive Industry. Güleş et al. (1997), Kozan et al. (2006), Wasti et al. (2006), Wasti and Wasti (2008 and 2009) are some

of seminal studies that have pointed out the composition of buyer-supplier relationships and the role of trust in sustaining them. For example, Güleş et al. (1997) argue that Turkish Automotive Industry had entered into a new phase, namely collaborative phase, by the beginning of 1997 and their main argument is that "the identified stages of Turkey correspond roughly to those for more developed economies" (Güleş et al., 1997, p. 209). Moreover, the subsequent studies examined the patterns of relationships through which buyers and suppliers interact within this industry. Wasti and Wasti (2008 and 2009) argue that soft technologies and informal commitment increase trust as expected. Wasti et al. (2006, p. 947) also suggest "strategic partnership led to cooperation in both buyer and supplier side and to satisfaction, mutual understanding and equity in the supplier side".[13]

There are also several studies concerning knowledge, technology transfer, FDI, suppliers and local competence building in the Turkish Automotive Industry (Ulusoy, 2003; Yılmaz et al. 2006; Gülşen, 2007; Samsunlu, 2007; Ekmekçi, 2009; Pamukçu and Sönmez, 2011; Ölmezoğulları, 2011, Karabağ et al., 2011; Özatağan, 2011). For the knowledge transfer, FDI and local competence building, Ekmekçi (2009) point out the position of local firms and MNC affiliates as follows: on behalf of local firms, their positions on the supply chain of their customer firms, the nature of their relationships with them, the channels, content and intensity of knowledge transfer from the foreign affiliates of the MNC customer firms all significantly affect the production and innovation capabilities of local firms. On behalf of MNCs' affiliates, the production scales, production and innovation capabilities and their positions in the innovation networks of MNCs are vastly interrelated and an affiliate gains more central position in MNC's network as they upgrade their production capabilities in time. Greater production scale, in addition, refers them to reduce production costs, to make greater investments for innovation skills and as a result, to strengthen their position against other affiliates of the MNC. By the time, more central position in MNC's network provides affiliates

[13]In their paper, they called "sample" rather than "side" for the group of firms they investigated in their model.

more design and development intensive work packages of MNC within product development projects and consequently, knowledge on design and development, even to a certain extent, flows from MNC headquarters to foreign affiliates. In the end, Ekmekçi (2009) conclude that for Turkish component supply industry, the strategy based on "low cost production" should be altered with "high value-added, original and branded-designs". This requires improving production capabilities into design capabilities. A further argument comes from Ulusoy (2003) who argue that in Turkish R&D activities, there has been a tendency towards development of production technologies in order to compensate the manufacturing costs and product quality requirements of customers and product technologies.New product development is generally ignored for this reason. This seems as one of the challenging points of the current state of the Turkish Automotive Industry. Besides this view, in a more recent study, Özatağan (2011) claim that in Bursa, component suppliers have gained the capabilities of design and product development and they have extended these capabilities on their former ones such as manufacturing with desired cost, quality and flexibility required by MNCs. Consequently, competent suppliers provide their services with less dependence on their customers. For the channels of this knowledge transfer from MNCs to suppliers in Turkish Automotive Industry, Pamukçu and Sönmez (2011) state that knowledge and technology transfer is sustained through:

> *(...) provision of information on documentations, logistic management, quality control, co-development activities, designing and cost reduction. Compared to foreign suppliers, local suppliers tend to be more frequently involved in those production and product related knowledge and technology transfers that are less knowledge intensive and of a lesser quality. On the other hand, being a direct supplier of automotive manufacturers in Turkey and, therefore, being more close to customers in the supply chain exerts a positive effect on the number of knowledge and technology transfers (Pamukçu and Sönmez, 2011; p. 31).*

Additional arguments come from Samsunlu (2007) and Yılmaz et al. (2006) who state that "today's production methods in Turkey are equivalent to those by the parent company at the international level" (Samsunlu, 2007; p. 45). Samsunlu

(2007) gave additional and remarkable information that despite the fact that Turkish supplier industries (TAYSAD members) have the ability to produce all the parts in a vehicle except spark plugs and carburettors; on intermediate parts, Turkey imports double its exports in volume. As Gülşen (2007) state for every hundred dollars of exports in supplier industry needs forty-six dollars of imports. Turkey has absolute deficit in intermediate parts of the automotive industry.

To sum up, Ölmezoğulları (2011) reviews the historical development of Turkish Automotive Industry as follows.In the beginning, main industrial firms had been established by license agreements. They were firstly protected by the government with import substitution policies and started their manufacturing on small scale. Governmental measures, moreover, helped to create a supplier industry with low technology and low capacity. Then, as a result, firms translated from assembly to process engineering phase. This helped them become good manufacturers in their areas of operation. In the 90s, product development phase had begun and R&D efforts took place. The main industry (MNCs affiliates) supported this phase since they needed cost reductions. Subsequently, as capable producers, Turkish suppliers have taken place as main supplier and exporter of some of the parts of automobiles that are produced in MNCs. At this point, upon his case studies concerning both the main industry and supplier firms, Ölmezoğulları (2011) criticises two important facts about the development of the Turkish Automotive Industry;

1) The small scale development and import substitution policies hindered the development of technological capabilities, for both suppliers and manufacturers, triggering the dependence of Turkish Automotive Industry to the foreigners,

2) Even though some of the capable suppliers and foreign affiliates have reached to critical threshold by attaining the position of "co-designer"; they are extremely dependent on the decision making issues such as technological development, R&D project development, supply policies and so on.

Ölmezoğulları (2011) concludes that Turkish industrial position has locked into the position of co-designer and the options of manufacturing under own brand seems not reasonable within given conditions.

To conclude, current literature essentially suggests that the Turkish Automotive Industry has reached a critical threshold and both affiliates of MNCs and their suppliers are capable of producing in world standards. They have begun to participate on co-designing phase of part or automobile development in selected projects; becoming as "co-designer" of MNCs and global industry. Nevertheless, the quality of this relationship is still questionable, ever since the locally-owned suppliers have not taken apart in more knowledge intensive parts of this interaction as argued by Pamukçu and Sönmez (2011). This might be related to non-existence of Turkish MNCs affiliates and suppliers on the decision-making processes of the global automotive industry. Lack of nationally-owned brand for both component industry and main industry has hindered the existence of Turkish decision-making on the global scale. The integration to world automotive industry after the removal of the import substitution policies implemented until 1980s seems effective and Turkey is stepping through from low value-added production centre to high value-added one but there seem some serious obstacles in this path. Particularly, the participation of decision-making processes is of vital importance for attaining this aim. For instance, in the development strategies of the South Korean Automotive Industry, South Korea has taken the role of decision-making processes in the global automotive industry by having established her own brands. South Korean brand, Hyundai, had lost great amount of revenue until it had clinged upon the US market during the 90s. The Korean government was back aside of its company during this period of loss. As compared universally, Turkish Industry is struggling particularly because of not having national brand and so, not having participation in decision-making processes of global industry. It is staying at the periphery as a consequence.

2.5. Findings and conclusion

In this chapter, we have examined the literature to draw a theoretical framework to our study. We have reviewed the literature on catching up and leapfrogging in

technological development, their relations with each other and with the Turkish Automotive Industry and the concepts R&D, innovation, R&D funding, the possible reasons of government intervention on R&D and the policy measures to increase the performance on R&D and innovation. The findings from the literature are to provide some invaluable insights throughout our study.

We can state very briefly these findings by combining the different facets of the literature as follows:

1) Catching up and leapfrogging may occur in the automotive industry following different paths. If the country has a process of catching up, she should run faster than the developed countries in the unidirectional path of technological development. If leapfrogging path is used, then the country should be more competitive or should find a new path by filling a conceptual gap to shorten the original path the developed countries has followed. The main theme of technological development is about combining technological development with market success. Market success is not sustainable unless it is accompanied by technology. Market success in exports does not mean that technology is developing as well. For instance, in the case of assembly line production of imported components most of the value-added is left in imported components and products.
2) The conceptual gap required to be filled for successful path-creating and paradigm-changing leapfrogging is necessary for successful industrial development. The prerequisite to achieve this goal is having successful R&D and innovation projects. Generating this kind of projects depends on several issues related to technological policy, reaching external knowledge resources and combining them with local capabilities, having centrality on global distributedness of innovation required by the automotive industry by participating decision-making processes with the provision of developing designing capabilities oflocal industry.
3) As technology evolves and globalization paces, the term ‘innovation’ and ‘R&D’ also evolves as well; and state-of-the-art of those concepts is

composed of interactive processes rather than isolated form of innovation environment. In the context of our study, there seems to be advantagesof examining whether R&D projects represents state-of-the-art approach of being interactive. The interactiveness between agents inthe R&D projects is to be investigated through firm cases (Chapter 5) and expert interviews (Chapter 6).

4) R&D funding is at the intersection of both market failure and SI approach and hence, is an important tool to compensate underinvestment problem inR&D and innovation. Successful R&D funding should increase the amount of private investment on R&D and innovation outputs such as product, process innovations and patents.It should, moreover, direct the firms to the behaviour of performing R&D at the world frontier. In our study, it is reasonable to utilize these concepts to detect whether the government interventions by using R&D funding schemes have directed the performance Turkish R&D in the automotive industry to a more sophisticated technological state. These aspects will be addressed in the core part of the thesis in the following three chapters.
5) On the market failure approach side, the problem for the optimal allocation of resources on R&D and innovation is simply addressed by government intervention through horizontal subsidies and thematic funding. Successful R&D funding should increase private R&D spending of firms (as innovation input), their product, process innovations and patents (as innovation output) and should change their behavioural patterns towards R&D and innovation. This is a significant finding since one of the case studies in this dissertation is specifically on an R&D funding mechanism designed and implemented by TTGV. The projects in TTGV data was subsidized through R&D loans, which is a convenient way to overcome the financial constraints of small and medium-sized firms as proposed in the current literature.
6) On the SI approach side, the situation about R&D and innovation is more complex. They are sourced from different bottlenecks in the innovation system and should be addressed specifically with different kinds of

government interventions and technology policies.Expert interviews in Chapter 6 and firm cases in Chapter 5 are to be utilized to find out the bottlenecks in the system by focusing on the R&D and innovation projects implemented in the automotive industry.

7) Automotive industry is scale-intensive industry with a low frequency of innovation. The global industry is well-organized; drawing high entry barriers that complicates the catching-up process. Tacit knowledge and reaching external knowledge resources are of crucial importance as it means that the industry is nourished by both local competitiveness and global attendance in the value chain. Technological trajectory is not fluid and the path of technological development and innovation are more predictable. This fact provides easier risk taking to invest on technology by implementing R&D and innovation projects that are capable of generating path-creating and paradigm-changing leapfrogging. Here, the central question is whether we should initiate adomestic brand that may be effective in achieving this aim. As mentioned, South Korean brand, Hyundai, and the government support on compensating its deficit is a good example of this kind.We would come back to this point in detail especially in Chapter 6.
8) By combining the above points with our findings from Chapter 4, Chapter 5 and Chapter 6, we will discuss possible policy measures for Turkey in Chapter 7. The increasing market success of Turkey does not guarantee a strong technological base for the automotive industry.We should investigate whether Turkey has sophisticated its R&D projects in terms of technology and R&D products. As Figure 3 has proposed, there are different paths of technological development and to attain path-creating and paradigm-changing leapfrogging promises special benefits for latecomers if only they are capable of achieving them by filling the conceptual gap required. To consider what type(s) of technological development path is suitable for Turkey is another concern for us in the thesis. Developing capabilities of Turkish firms on emerging and contemporary technologiesmay generate opportunities for the country to achieve the types of path-creating and

paradigm changing leapfrogging such South Korea and China experienced. It is commonly admitted by the current literature that Turkey has reached a phase of co-designer on supplier industries and a certain level of excellence on manufacturing. However, these do not guarantee that there is a certain kind of catching up. For the future, for instance, the non-existence of dominant design on electrical vehicle components may provide a considerable chance for Turkey as a latecomer to attain such kind of path-creating or paradigm-changing leapfrogging under appropriate policy measures to be designed and implemented. This requires fixing the systemic failures in the innovation system in order to fulfill the gap required to reach the technological level of the forerunners.

In conclusion, successful catching up and leapfrogging in technological development process is accomplished by successful government intervention addressing effective R&D and innovation policies to overcome resource allocation problems and addressing systemic failures by implementing policies that enhance information flow among agents in the system. R&D funding mechanisms implementedin the automotive industry should increase innovation inputs and outputs bychanging the behaviour of firms to uptake more sophisticated R&D and innovation activities that are at the world frontier. It should create sustainable environment for technological development initiatives to accompany market success withtechnological developments. With its process and scale-intensive nature, successful funding for process innovations is crucial for the automotive industry to accelerate industrial development. As in the Hyundai case, R&D funding mechanism should foster the efforts of “bigger” R&D projects where policy makers are willing to support catching up and leapfrogging initiatives on the areas in which technological trajectory is predictable and sunk costs are low. Furthermore, successful systemic technology policies should overcome systemic failures and bottlenecks in the system. For example, it should foster interaction among agents within the sector to trigger new knowledge flows, technology transfer and interaction with global industry by upgrading absorptive capabilities through learning and effective networking. It should enhance the system by

upgrading current institutions or generating complementary institutions that is currently missing. All of these are to be discussed for Turkeyon the basis of different policy measures outlined in this chapter.

Finally, on behalf of the Turkish Automotive Industry, current literature put emphasis on the strongproductive capacity. It is certainly clear that the joint venture structure of the industry has helped Turkey to enhance manufacturing capabilities. However, it is questionable whether this structure and strong manufacturing base would help Turkish Automotive Industry to develop technologically. One of our central purposes in this thesis is to investigate the necessary conditions for a successfultechnology upgrading and whether this can be based on the current structure of the industry. In short the question is where does Turkey see itself in about twenty-yeartime: a production or a technological hub? A successful R&D funding scheme should feed up the industrial structure to a better performance by fostering technology-based product, process innovations and concept designs in order to realize technological development paths. This requires filling the conceptual gap; performing the actions to take part in the decision making processes of R&D and innovation activities. With these facts in mind, we further question whether there is a transition of such kind in the development of Turkish Automotive Industry throughout this thesis. If this is not the case, we discuss what can be done to overcome the problems in the existing system in the policy chapter.

CHAPTER 3

Methodology and the Research Questions

3.1. Introduction

Research is the systemic process of collecting and analysing information and/or data through the phases of planning, data collection and analysis in order to augment our understanding about the phenomena we investigate. Successful research requires a clear problem definition and goal which can be attained by successfully identifying the problem. In complex issues, problems should be divided into sub-problems. Researcher has an intention and belief to understanda topic; then, generates hypothesis, sub-hypothesis and related research questions.

In this chapter, the main research problem of this thesis is identified by posing convenient research questions and sub-questions. A research design is proposed by using scientific principles and methods appropriate for investigating the research questions and the theoretical background behind our study. The mixed approach involving both quantitave and qualitative methods is a major novelty of this thesis. The phases of empirical research and the methods applied during these phases are presented for the reader to provide a thorough understanding of our methodology. Finally, validity and reliability of the research are put forward to prove the scientific quality of our approach.

This chapter gives a brief sketch of the methodological approach. Details regarding the quantitave analysis and qualitative research, case selections, questions and interviews are given in chapters 4, 5 and 6. In this way, we aim to increase the readability of each chapter.

3.2. Problem Identification

As the literature review suggest in section 2.4., despite the development attained in some areas, Turkey has not succeeded in several aspects of the automotive industry such as compensating its imports with exportsuntil 2008 (except several years during the economic crisis); not bridging OEMs to their suppliers; not sophisticating its R&D products and not attaining to reach the phase of R&D intensive domestic industry while maintaining its position as an excellence center in manufacturing. These points breed suspicion about the success stories of the Turkish Automotive Industry, particularly generated in the last decade.The main problem of this dissertation is questioning this suspicion scientifically by using several scientific methods including data analysis and case studies. Both quantitative and qualitative methods are utilized in order to overcome some bottlenecks inherent in studies that use only quantitative or qualitative methodology. The problem is handled somewhat in a different manner and approach to investigate the R&D support mechanisms, automotive industry and industrial catch up. The study is designated to provide answers to questionwhether Turkey has succeeded in catching up in terms technological development and thesophistication in the R&D projects compared to the Global Automotive Industry.

With that consideration in mind, we have constructed the main hypothesis of the study as such:

Main Hypothesis: Despite its renowned export success, Turkish Automotive Industry has not succeeded in catching up the forerunners of the industry in terms of generating R&D and innovation projects that are more sophisticated and capable of generating more competitive R&D results.

At this point, we should question how we test our hypothesis? What kind of sub-hypothesis should we generate and research questions should we ask? What methodologies and methods should be employed? How do we justify this choice? What is the uniqueness of our research? How can the validity and reliability of our

research be sustained? All of these questions are to be answered in the subsequent parts in this chapter. But now firstly, we begin by posing our research questions.

3.3. Research Questions

This research is sustained through main and sub-research questions to test the hypothesis proposed above. Appropriate research questions are capable of dividing the problem into manageable parts to easily identify the main problems to investigate. The focus of the research questions is carried upon the main problem not to be departed from the main question being concerned. Then, we establish the research by posing main research question and its sub-questions as such:

The main question:

- Has Turkey advanced its manufactured products by generating more sophisticated R&D projects in the upper tiers of the Global Automotive Industry? Is there a catching up or leapfrogging in this sense?

The sub-questions:

- How are catching up and leapfrogging attempts achieved in contemporary Global Automotive Industry? What is the role of R&D projects and subsidies in this process?
- Has Turkey manage to manufacture technologically more sophisticated products in its Automotive Industry by benefiting from R&D subsidies?
- What is the technological level of the R&D projects in the Turkish Automotive Industry? Is there a transition to more sophisticated technologies in this sense?
- If Turkish Automotive Industry is not able to achieve a more sophisticated technological level compared to its peers in theglobal automative industry, what might be the reasons? Can this situation be perceived as a sign of middle-technology trap?
- What are the possible policy recommendations for the Turkish Automotive Industry to overcome the mid-tech trap?

To assist the reader in the rest of this thesis Table 2 proposes the linkages between research questions and the chapters of the thesis.

Table 2 Research Questions and studied chapter in dissertation

Research Question	**Studied Chapter in dissertation**
How are catching up and leapfrogging attempts achieved in contemporary Global Automotive Industry? What is the role of R&D projects and subsidies in this process?	Chapter 2
Has Turkey manage to manufacture technologically more sophisticated products in its Automotive Industry by benefiting from R&D subsidies?	Chapter 4
What is the technological level of the R&D projects in the Turkish Automotive Industry? Is there a transition to more sophisticated technologies in this sense?	Chapter 4
If Turkish Automotive Industry is not able to achieve a more sophisticated technological level compared to its peers in the global automative industry, what might be the reasons? Can this situation be perceived as a sign of middle-technology trap?	Chapter 5 Chapter 6 Chapter 7
What are the possible policy recommendations for the Turkish Automotive Industry to overcome the mid-tech trap?	Chapter 7

By answering these questions in the related parts of the thesis, we expect to address the main problem and upon these findings; we construct future policy recommendations for the Turkish Automotive Industry.

3.4. Research Design and Methodology

This section outlines research design and methodological approach of this dissertation. A research design provides the framework for the collection and analysis of data. In fact, research design is about determining priorities being given to the different dimensions of research. It requires appropriate methods to gather data by using different techniques in a wide array from questionnaire, self-structured interviews to several kinds of data resources. Research methods contain different research tools such as library resources, computer software, measurement techniques, statistics and so on and by using these tools in a scientific methodology, research design should address the purpose of the research by establishing units of analysis, points of focus and time dimension of the study. Designing a research has two phases, namely, conceptualisation and

operationalisation where the design should be reliable, replicable, and valid as to be further mentioned.

In order to carry out the research, as mentioned, we have three pillars in the literature about the topics including R&D funding, automotive industry and industrial catching-up. Chapter 2 reviews these parts of the literature by specifically aiming at helping us to design the main setup and approach of our investigation. In order to narrow down the scope of the research due to time and space limits, R&D projects in automotive industry are taken as the main determinant of Turkey's R&D efforts and models of leapfrogging and catching up are utilized to analyse Turkey's position in the global automative industry.

For methodological approach, this study utilizes mixed research involving both quantitative and qualitative methods in order to establish valid and reliable results. As quantitative approach, TTGV [14] data, covering a 20 years of R&D subsidization[15] period in Turkey from the beginning, are evaluated in terms of a given hypothesis for technological sophistication of the supported projects in the automative industry. Due to data limitations, two qualitative case studies - expert interviews and firm cases, were conducted to test the robustness of the findings of the quantitative phase. In the firm cases section, semi-structured interviews with 13 different firmsthat at least once had submitted an R&D project to TTGV, have been conducted with firm responsibles (particularly with R&D managers). Firms have been selected from a portfolio of TTGV data by paying attention to different indicators such as firm size, firm location, accessibility, its tier in the industry and so on. In the expert interviews, semi-structured interviews have been held with the experts who have invaluable insights and who mastered the backgrounds of the Turkish Automotive Industry.There are 14 experts from different professional backgrounds such as policy-makers, technology specialists, R&D managers,

[14] The first R&D funding institution in Turkey.

[15] TTGV provided R&D loans, indeed; and whether the R&D loans might be approved as subsidization or not is a debate we have held in section 2.3. Throughout the thesis, we have assigned TTGV support as a subsidy, approving the fact that the support was highly desirable by applicant firms during the period of high inflationary rates until 2003 and until the support provider institutions was increased in numbers between 2003 and 2007.

technology consultants in a wide array of professional spectrum. From the interviewees, their opinions about the historical aspects and current structure of the industry are taken which are of utmost importantin answering the research questions. All these interviews have provided answers to current research questions of the dissertation, but most importantly giving the opportunity to validate the findings in Chapters 4 and 5.For representativeness, firms are selected from different core specializations, different types and different sizes and experts are chosen from different areas of expertise. In order to generate an outlook out of the automotive industry, two of the experts are from the electronics industry which is highly affiliated with the automotive industry especially when sophisticated R&D projects are the concern. The interviews have been terminated when we obtained similar types of answers to our questions during the interviews and no additional appointment has been made.

Why mixed research approach and case studies were chosen in this dissertation? In order to answer this question effectively, a discussion is held in the Research Method section concerning quantitative, qualitative and mixed design of research by revealing their advantages and disadvantages (Section 3.4.1.) and then, we discuss why mixed approach is appropriate for our research (Section 3.4.2.). Next, how the phases of our research constructed is explained and then the research instruments are identified in the next section (Section 3.5.). The case studies, the selection of experts and firmsare explained and finally, the validity and reliability of the selected research methods and instruments are discussed in the last section of the chapter (Section 3.6).

3.4.1. Research methods

In the 20th centurytwo research methods; namely, quantitative and qualitative methods has widely been used. Quantitative methods in social sciencesare utilized to investigate social problems by incorporating quantitative data measured in quantities and calculated by statistical procedures. In contrast, qualitative research is used to address problems by utilizing data formed from words, expressions, explanations etc. (Cresswell, 1994; Ekmekci, 2009).

Research can be defined as the detailed study of a phenomenon in order to discover new facts and novelties. Research methodology, as a result, can be referred as the way of scientific understanding to undertake the research. As Desphande (1983) claims research method determines the research design including the methodological approach, tools and research instruments. Moreover, as Cresswell (1994) adds up research methodology is mainly determined by the nature of the research question, the past experiences, the existing knowledge base and philosophical approach of the researcher (Rudestam and Newton, 1992; Ekmekci, 2009).

Quantitative and qualitative methods also differ in terms of their philosophical origins. Quantitative method is perceived as having a positivist roots and deductive approach that is verifying or falsifying current hypothesis by using experiments and measurable methods. Qualitative method is philosophically empiricist and relativist with respect to its data gathering by using individual cases with direct experience (Creswell, 1994; Perry, 1998; Hyde, 2000; Bechara and Van de Ven, 2007, Ekmekci, 2009).

At the ontological dimension, quantitative method perceives the nature as "one singular reality" that is objective that can be counted in numbers and measured in quantitative terms. In contrast, qualitative method argues the term "objective" has relatively changed and depends on the interaction between the researcher and what is being studied. This method strongly opposes "one singular reality" and "objectivity of truth" and suggests the dependent nature of research results upon the interpretation of the researcher (Feyerabend, 1975; Creswell, 1994; Ekmekci, 2009).

At the epistemological dimension, quantitative research argues researcher should be isolated from any side of the research and objectively he/she should perceive the truth by neglecting his/her personal believes (Denzin and Lincoln, 1998). In contrast, as Latour (1987) claims, in qualitative research, researcher should be in close relationship with what is being studied to understand it in a more comprehensive and coherent manner (Ekmekci, 2009).

Finally, at the methodological dimension, quantitative method uses numbers and measurable statistical data; hypotheses are tested with the measurement of variables and independent variables on cause and effect relationships. Deductive results are obtained from these measurements by testing reliability and validity. Hypotheses are defined a priori by the researcher at the beginning of the research. In contrast, qualitative research uses a different inductive logic and variables emerge as the data collected by the researcher rather than a priori (Rudestam and Newton, 1992, p. 32; Ekmekci, 2009). Thus methods differ in data gathering. Quantitative approach use experiments, questionnaires and structured interviews as the way of data collection while qualitative research utilizes observations, case studies, semi-structured or in-depth interviews. Quantitative research requires relatively large samples in contrast to qualitative research which utilizes smaller number of cases for deeper analysis.

As Creswell (1994) proposes, no method is superior to another. Each methodcan be used according to its appropriateness to research questions and unique conditions inherent to the research in hand. Furthermore, mixed approach containing advantages of each type might be utilized in order to find out coherent answers to research questions studied. The complex nature of the problem and/or current data sources may have prerequisites for this kind of approach. Creswell (1994) certainly argues that researcher's point of view, his/her previous experiences, nature of the problem, and data availability as a whole might affect the methodology utilized by the researcher.

Ekmekci (2009) stated that "while some certain questions require a quantitative approach, some other may be suited well with qualitative, exploratory and descriptive analysis". Quantitative research may well be exploited if there exists well-known variables in the literature requiring no additional exploration. In contrast, quantitative research is made use of in cases where variables are not well-established in the literature and when they are "untouched", "incomplete" and need further explorations. Mixed research lies between these two approaches and may have both well-known variables and "untouched" ones where additional

exploratory research is required (Creswell, 1994). Table 3 depicts all the explanations in brief.

With these explanations in mind, our research requires appropriate research design to address our research questions and to test our main hypothesis about the Turkish Automotive Industry. Our research approach should be well-established to illuminate our considerations about how the research is sustained throughout the study and how it should be designated on this basis of validity, reliablity and applicability. Subsequent part of the chapter is devoted to explain these considerations.

Table 3 Research methods in a glance

Research Method	**Requirement**	**Advantage**	**Disadvantage**	**Focus**	**Array of explanation**
Quantitative	Sufficient data and no. of samples, well-known variables, theoretical and econometric models, explanatory research	Needs less time, more reliable and generalizable	No depth analysis for the reasons in complex systems	Macro	wide
Qualitative	Less number of samples, more time to be realized, explarotary research	illuminate "untouched" and incomplete variables	Needs more time, depth of analysis on micro basis, says little about macro analysis	Micro	tight
Mixed	sufficient time to be planned and organized, both types of research, mixture of well-known and "untouched-incomplete" variables	compensate the deficiencies of others, much more generalizable results obtained, appropriate for complex systems	Needs the most time to be realized, more demanding for operationalisation of the study	Both	wider

3.4.2. Selected research methods and research design

The selection of the research method is an ongoing debate in "innovation studies" discipline. Quantitative analyses are held by using Community Innovation Survey and Innovation Scoreboard data and indicators (European Commission, 2002;

Schinaby and Streicher, 2008), particularly performed by the European Union. This research specifically focuses upon R&D inputs and outputs such as R&D expenditure per capita, patents etc. In contrast, qualitative research is sustained through firm-based studies with interviews and in-depth analysis. Quantitative research has strength on cross-country comparisons while qualitative research strongly argues that only numbers for R&D expenditure, patents are not sufficient to sustain a research for a complex concept like innovation.Detailed micro level studies are more open to expose facts behind this complexity (Ekmekci, 2009). Mixed approach is on the other hand, rarely used in innovation studies because of the complexity of the methodology and necessities it requires.

The methodological design of the thesis is based on mixed approach because of the complex issues inherent to our research. Since the main aim of the dissertation is to investigate howR&D performance of the Turkish Automotive Industry developed; we specifically aim to investigate the dynamics of this development. As we investigate our possible data resources TTGV data in which we have a sample of automative industry related R&D projects stands out. The most suitable time period for our investigationis the period whenthe national auto industry is flourishedtogether with increasing R&D supports from the government. TTGV data emerged as appropriate for this purpose, covering this period from the beginning, the year of 1991; where the first R&D support had begun to be provided by this institution, even before TUBITAK. Until the end of 2011 firms applied with 102 projects in the Automotive Industry to receive financial support from TTGV.This 20-year sample covers the longest time period in the Turkish R&D funding history. It should be noted that this period can be perceived as the intensification period of R&D performed by the Turkish Auto Industry[16].

In our research, we used the data provided by TTGV to set up hypothesis regarding technological sophistication of the R&D projects performed. This method has proposed new terms which used in TTGV project evaluations, such as innovation level, technology field and market orientation etc. This is the starting point of our

[16] This argument is to be further discussed in Chapter 4.

research but TTGV data has serious limits to overcome. First, despite its benefits, the results that we found using this data may not fully cover the current state of the Turkish Automative Industry. It has some limitations such as budget limits, changing attractiveness through time for the applicants, SME-tended nature of the supports etc. as to be further explained in Chapter 4. Second, R&D funding mechanisms has been rapidly changing in different periods of time and new players such as TUBITAK-TIDEB, KOSGEB, local development agencies has taken an expanding role in the Turkish Innovation System by providing subsidies to R&D projects via using similar mechanisms as TTGV. Rather than TTGV's soft loan with back payment, these institutions have been providing grants which are much more attractive for the applicant firms. This has dramatically changed the R&D funding scheme throughout the innovation system; applicant firms has established new strategies in a 20 year-period of time to exploit them. Third and the last, we have analyzed the TTGV data in a very different manner with respect to current literature for R&D funding evaluations. The basis for addressing the research questions is to find out the advancement of R&D projects in terms of technological sophistication rather than input or output additionality evaluations of funding schemes which needs a different kind of approach. The literature is very limited in this sense which makes our work difficult to back up and compare with the other studies in the literature. This was one of the reasons why we utilized a mixed approach and designed case studiesto increase the robustness of the findings in Chapter 4.

One method for further data collection is to apply TUBITAK for its project archive related to Automotive Industry Projects. The first and the most important barrier to do this is, due to safety contracts, it was not possible to have permission from this institution. Data collection from this archive, in addition, would require much more time than expanding TTGV data because the number and the files of TUBITAK projects are considerably different from TTGV. These differences would also make comparisons with the TTGV datahard. The study would not gain more reliability and validity had we used TUBITAK data in a similar manner. It is for this reason

that rather than using another quantitative data source we opt for detailed firm analysis and expert interviews.

In order to deepenthe quantitative research using TTGV data we tried establish a comparison basis. We were trying to evaluate the R&D projects, so we attempted to obtain their value-added using a selected Joint-Venture made automobile as a case. For this reason, with the help of OSD[17] General Secretary, Prof. Dr. Ercan Tezer, we tried to obtain the prices of individual automobile parts from the Turkish Auto manufacturers. We tried to acquire the most intensifying parts of the value-added in an R&D project. We proposed a petition to OSD member joint ventures to gather data on this subject. The petition also involved a list of parts and components, proposed by Altay (2003), suggestive to our purposes[18]. To our knowledge, possibly due to difficulties in data gathering, this type of value-added analysis combining with R&D projects has never been succeeded in the literature. But as expectedly, because of confidence and privacy reasons, it was not possible to collect this information and this extension of the quantitative research was not realized.

To expand our research, there remains qualitative research as the sole option to gather additional information to maintain scientific reliability and validity. For this reason, in addition to TTGV data, we designate firm visits and expert interviews about the R&D projects in the automotive industry that will permit a deeper understanding. This method inherently has the capability to form a deeper understanding of the history of the Turkish Automotive Industry providing a chance to look from the firms' and experts perspective. A micro-based approach (Chapter 5) as well as macro-based research method (Chapter 6) would further widen the spectrum of this dissertation. So, we are confident that the finding achieved in the expert interviews and firm visits are complementary to the results

[17] OSD (Otomotiv Sanayicileri Derneği) is the Turkish abbreviation of "Automotive Manufacturers Association" in Turkey.

[18] The petition might be seen in Appendix A. The petition was signed by TTGV Technology Development Projects Group Coordinator, Mr. Yücel Telçeken, in order to augment the immensity of the request.

of the quatitative part that analysis TTGV data. In short this thesis can also be views as an extensive robustness analysis.

In terms of our research design, during the expert interviews, opinions about historical facts, information about global automotive industry, policy measures and R&D projects have been gathered and the grassroots of firm visits have been established. In addition to quantitative model of Turkish R&D projects in terms of the dynamics of technological sophistication term gathered from the TTGV data; semi-structured interviews with experts have offered new information to validate and further expand the findings. For attaining this aim, 14 expert interviews from reputative institutions have been held in a semi-structured interview format. By combining findings of these interviews with the very findings of this dissertation, semi-structured face-to-face interviews have been realized with 13 different firms having R&D projects submitted to TTGV. The details of these interviews are explained in the next section and further details are left to subsequent chapters.

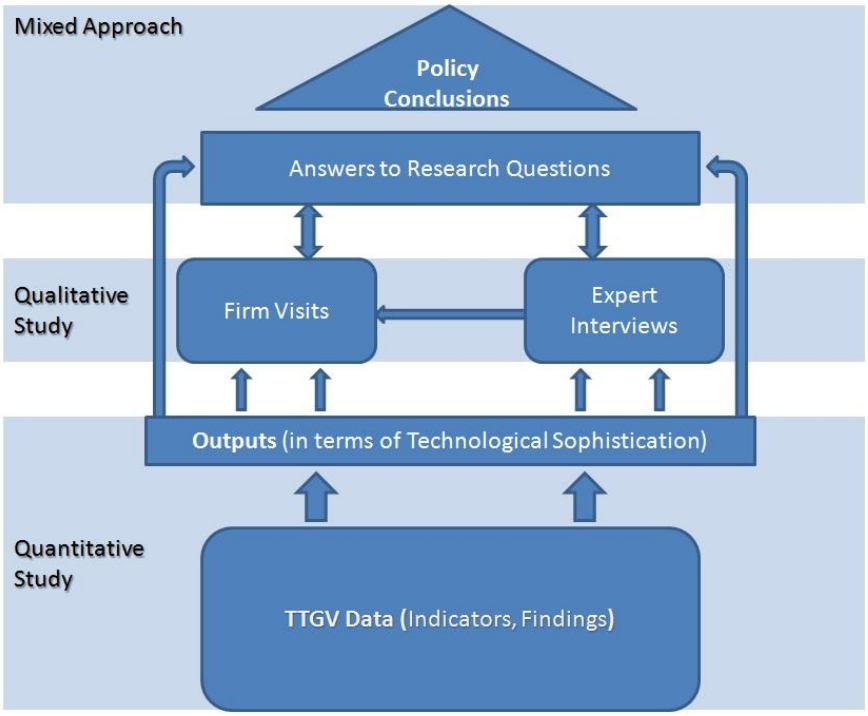

Figure 5 The Mixed Approach and its components

To sum up, this research offers a mixed approach involving both quantitative and qualitative methods (Figure 5). This way of a methodology design was a necessity as we think of the complexity of the problem we tackle, lack of accompanying literature (especially in terms of technological sophistication, mid-tech trap and TTGV data analysis from fact sheets) and difficulty in data gathering (Table 4). We should also mention that without TTGV's support on the data availability, expert interviews and firm visits, it would be impossible to widen this research as such, hard to collect data and to propose a mixed approach suggesting complementary answers to the research questions. We assert that the dynamic analysis of R&D projects by using both quantitative and qualitative data would provide a fresh understanding of the literature at the junction of R&D funding, industrial development, catching up and innovation studies. We strongly believe thatthe mixed approach utilized in this thesis and its structure has a unique contribution to the current literature of concerning fields.

Table 4 Research design in brief

Method	**Study**	**Outputs**	**Limitations**	**How to overcome**
Quantitative	TTGV Case Study (R&D projects)	Dynamics of the automotive R&D projects in terms of technological sophistication	Generalizability problems for the industry as a whole	Further qualitative studies to be able to overcome its limitations
Qualitative	Firm cases	Historical projection of R&D projects at a glance, tracking the evolution of sophistication of firm capabilities and R&D projects performances	Possible constraints of firms on reflecting the essence of projects due to privacy concerns	The outputs of other studies in the thesis may fill the missing points
Qualitative	Expert interviews	Historical policy perspective and general understanding of the Turkish Auto Industry, questions to ask in firm visits	Possible subjectivity of scholars	Scholars ranging from different backgrounds may overcome the subjectivity problem. Moreover, the first two studies may provide validation.
In Sum:				
Mixed Approach	A quantitative and two qualitative studies	Answers addressing research questions, recommendations for policy design, possible support for the main hypothesis	Time limitations for evaluating R&D projects in the quantitative study and for organizing the case studies	Better problem identification and method to deepen our understanding

3.5. Phases of the Empirical Research

This research is designed as three interdependent phases. The first phase is composed of the literature review and TTGV data analysis providing a solid ground for the second phase. The second and third phases of the research are mainly based upon the first phase and involve qualitative case studies; namely, firm cases as providing micro evidences and expert interviews as macro evidences. The outputs of the first phase are strongly required for the second and third phases, supplying complementary information in order to better respond to the research questions.

3.5.1. The First Phase

The first phase of the study startswith the literature review in Chapter 2. Literature is built upon catching up and leapfrogging in technology development in relation toR&D funding, rationales for government intervention and the automotive industry. Despite the fact that no similar study -based on mixed approach and evaluation of R&D funding such as this thesis offers- has been done in the literature some initialfindings paved the way for further analysis in chapters 5 and 6. In addition, as a quantitative study, TTGV project proposal data has been acquired after about a 250 hour-time and 3 months of research throughout TTGV project files in the archive. Automotive projects have been selected from a group of almost 500 applicant project files classified under the name of Mechanical Projects in TTGV evaluation. At a first glance there seems to be 102 automotive projects that can be used in our research. However, after a detailed examination86 of them has been regarded as to be beneficial for the research purposes since others has missing information in the files (that makes it difficult to identify the projects as an automative sector project). The variety of applicant firms and project types are quite different and there are many information and data about both projects and applicant firms. It is also possible to find some extra information about the results of the projects. The information possible to obtain from the project files have been grouped under the name of firm data, project proposal data and realized data sections. Firm data section has the information about the applicant firm including its firm structure while project proposal data contains the information about R&D project proposal like project budget, type of innovation etc. Finally, realized data

section involves information than can be gathered after the project ends[19][20]. The provided data from these files have been taken on an excel sheet by dividing them into different indicators. Using this rich source of information reliable indicators like technological field, innovation level etc. are formed to establish a hypothesis in accordance with the definition of technological sophistication, putting forward the dynamics of technological development in R&D projects of the Turkish Automotive Industry[21]. With the provision of this chapter, we have the opportunity to test the concerning hypothesis about the stability of technological sophistication in Turkish R&D projects. During the data work we also collected the issues and outputs as findings about what can be asked in the subsequent phases of the thesis. This research in the first phase of our study has provided a good base for the succeeding research.

3.5.2. The Second Phase

As to be explained in Chapter 4, and due to difficulties mentioned in Section 3.4.2., TTGV data has limitations which made us to set up the qualitative analysis in Chapters 5 and 6 on the results achieved in Chapter 4 specifically focusing on the points where our findings needs further validation. For this reason, as a second phase of research firm visits are designated to expand our research.

Firm visits have been planned to interview with firms which have been supported by the TTGV in the last five years. The time limit as five years is established to have ease in data collection because it is hard for a firm to say something about the project outcomes that were completed long time ago. The firm visits are, at first, planned to involve 15 firms (selected from the TTGV project performers) to easily gather data by face-to-face semi-structured interviews. Weexpected that there would be a saturation and convergence of perspectives of firms regarding the main

[19] The details of this data will be provided in chapter 4.

[20] Due to inappropriateness and unavailability in realized outputs of the most of the projects, the realized data section had not been utilized in the further phases of dissertation.

[21] This model is explained in detail in Chapter 4.

points as we slowly reach the targeted number of firms.[22] The list of interview questions has been obtained from the expert interviews being held simultaneously and also from the vast literature on R&D funding and technology development. [23] The list of firms is presented in Chapter 5. The basic rationale of the selection process is to involve different type of firm categories and firm locations to maintain the variety of firms in the TTGV data so to have more generalizable results.

We strongly believe that firm-based interviews give us invaluable insights about the micro evidences for the research questions. We may also find the possible bottlenecks impeding firms to produce more sophisticated R&D projects.

3.5.3. The Third Phase

In order to have macro-based evidence for our research, we have designated expert interviews involving 12 professionals from the Turkish Automotive Industry and 2 scholars about R&D in Turkey as listed in Chapter 6. The experts who worked or are still working in firms and organizations as a part of the automotive industry are specifically approached to have an overview of the automative industry in general.

The list of experts has been constituted by the aim of involving different facets of the Turkish Automotive Industry. The list involves policy-makers, professionals in JVs, Turkish OEMs, suppliers and engineering firms, historians and technology specialists to cover diverse aspects of the issue. We believe this composite and widening understanding of research provides a comprehensive look for global as well as the Turkish Automotive Industry. The interviews with these experts involves questions related to the history of the Turkish Automotive Industry, global automotive industry, implemented measures and policies, historical breakthroughs and mistakes, Turkish R&D funding schemes, Turkish R&D within

[22] 13 out of 15 firms were interviewed.

[23] The detailed explanation of interviews and list of the questions are given in Chapter 5 and Appendix C, respectively.

automotiveindustry and industrial catching up etc.[24]. The supposed benefits of the semi-structured interviews are summarized as:

- To validate the findings in the other chapters,
- To design a firm-based case study related to the R&D funding and catching up in the automative industry,
- To attain more insights for the historical perspective of the automotive industry from the experts,
- To further understand the sectoral position of Turkey in a global setting.

Given the expected benefits of the research, these interviews can also be viewed as a robustness check of the findings in other chapters. We consider that this last phase would involve macro-evidences for our study.

3.6. Validity and Reliability

Reliability is in a sense can be viewed as the replicability of results obtained from research. In addition, validity refers the usability and acceptability of research results within time limits and selected conditions. Both terms are important in academic research since reasonable and acceptable outcomes are expected from research efforts. For this reason, several resources such as interviews, data, organizational reports, web sites, news in mass media are utilized in academic research in order to compensate the requirements of validity and reliability in addition to the academic literature.

This dissertation used TTGV data, interviews with experts and firm responsibles as the first source of data gathering and current mass media resources, web sites, annual reports of different Automotive institutions such as OSD, TAYSAD etc. as secondary sources concerning Turkish Automotive Industry. As Patton (1987) and Yin (1994) proposed, 'data triangulation' by using different kinds of resources is important for maintaining validity and reliability of the research. As such this dissertation makes use of the related diverse sets of information that are obtained

[24] The details of the expert interviews and its questions are to be provided in Chapter 6 and Appendix D, respectively.

through a mixed methodology approach. The uniqueness of this research is about combining quantitative and qualitative research by using mixed approach and about gathering some additional information from secondary resources such as the historical experiences of the Devrim case. With its comprehensive look provided by the variety of resources given, we argue the outputs of this research are offering valid and reliable findings for our research problem.This mixed methodology could be utilized for further studies to provide invaluable insights for government intervention on innovation and to test whether the technological sophistication of the subsidized R&D projects matches the goals of designed policies and support schemes.

CHAPTER 4

The Dynamics of the R&D supports on Turkish Automotive Industry: The TTGV case

4.1. Introduction

The main aim of this chapter is to determine if there is a considerable increase in technological sophistication of R&D projects in the automotive industry. To attain this aim, we first need a sample involving certain aspects of R&D projects in Turkey. As to be stated later in this chapter, TTGV data including a suitable sample covering a 20-yearperiod have been selected. What makes the data interesting is that it covers the whole R&D subsidization period in Turkey from 1991 to 2011.[25] Thanks to the data provided by TTGV, the main focus of this chapter is to measure the technological sophistication of R&D projects in a selected timeframe exhibiting longitudinal aspects giving a dynamic approach to our investigation. For this reason, we have performed an in-depth analysis of each project proposal by benefiting from its documents and reports in the TTGV archive.

In this chapter, firstly, we will begin by a brief explanation of TTGV. We shortly explain how and why TTGV was established by mentioning its brief history. We state the details of the funding mechanisms of TTGV from which we have obtained the data for the automotive industry. At the end of this discussion, we give some general statistics about the supporting programmes of the institution to represent its

[25] The other aspect important for us is its accessibility by the researcher, which is not ensured by other subsidy providers. Moreover, the researcher of the thesis is capable of reading certain confidential aspects of the projects by employing his job experience in this institution.The data has been provided in terms of security contracts signed between TTGV and the project proposers. No firm name is given in the dissertation.

role given different conditions emerged in different time periods over these two decades of time.

Secondly, we mention about the data we have obtained and how we classify it in terms of our purposes. We also indicate what this data involves and what it is symbolizing. Since there are some constraints inherited in data related to time, space and funding mechanism implemented by TTGV, we state these limitations and weaknesses of the data as well, in order to induce new exploratory research that may overcome these deficiencies. We give general findings and statistics about the data before we investigate them in detail.

Thirdly, we develop a simple measurement technique calculating the dynamics of technological sophistication of industrial R&D projects in the TTGV data; their change in different time periods in terms of innovation level, technological field, market orientation, design intensivity and OEM presence, innovation type, customers of project outputs, compensation period and R&D complexity. By using the data, these indicators will be used to test the hypothesis whether Turkish R&D efforts has taken a level up and has reached a critical threshold as expected bythe given R&D supports.

Finally, we conclude the chapter by reviewing our findings about the general technological development pathof the Turkish Automotive Industry. Wealso determine the issues to be explained in the subsequent chapters based on two case studies.

4.2. A brief explanation of TTGV

To explain quantitative analysis, we should firstly introduce TTGV by explaining its history, structure and function in R&D funding schemes within Turkish Innovation System. For this reason, we start by a brief history of the institution, explaining its supporting schemes to comprehend how the projects in our data were being subsidized.

4.2.1. A brief history of TTGV

The establishment of TTGV is an exceptional issue in Turkey with its very different nature as an agency in the Turkish Innovation System. We should initiallyput forward the situation of Turkey during its establishment period. Turkey was experiencing a transition period Turkey since 1980. The focus of the ruling economic policy was transformed into an export-oriented regime in accordance with the emerging globalization trends throughout the world economy. The industrialists had begun to look for new factor inputs and a way out to enhance competitiveness. Under these circumstances, Technology Development Foundation of Turkey (TTGV, Turkish acronym) was founded in 1991 as a major player in supporting technology development. The foundation was established by replicating a cooperation project between South Korea and the World Bank that was just completed successfully. It was prominently aiming at compensating financial requirements of the Turkish industry to develop technology (Göker, 2008; p. 54). The functions of the foundation were determined by the officers both from the Turkish government and the World Bank and can be stated as follows:

- To increase the competitiveness of Turkey in international markets,
- To provide the mechanisms of seed capital required for the improvement of Turkish industrial infrastructure (Göker, 2008; p. 55).

World Bank provided 100 million US dollars to Undersecretariat of Foreign Trade[26] and the 43,3 million US dollars of this amount was given to TTGV as a gratuitous transfer in order to subsidize firms by supporting several kinds of projects concerning research, development, technology adoption and to contribute financially to Strategic Focus Projects for enhancing R&D potential and technological infrastructure within the country. In the agreement, there was a remarkable point that TTGV was responsible for compensating its own operating costs and the transferred amount was excluded from the operation. TTGV was obliged to pay at least 20 percent and at least 33 percent of its operating costs on its

[26] Undersecretarait of Foreign Trade was the former name of current Ministry of Economy of Turkish Republic.

own from the services it provided. It was established as a non-profit organization. Supports were under the control of Undersecretariat of Foreign Trade and independent auditors.

The major mission of TTGV was to bring out competitiveness to Turkish industry competing in global markets and it was the forerunner of all subsequent R&D support mechanisms in Turkey. TTGV was a unique example that was established in the status of a "foundation" because of its appropriateness to legal structure of that time. As Göker (2008) stated, the aim was to provide an independent entity which was flexible and in which public and private sector had equal effect in the process of decision-making. The board of directors were composedof both public and private delegates. As a result, despite the fact that TTGV was mainly under the ownership and supervision of the state, it was also an autonomous and independent entity as well (Göker, 2008; p. 58).

In 1999, "Industrial Technology Project" (ITP) was signed as an extension of the former project between World Bank and the Turkish Republic. TTGV was assigned as a partner on R&D funding; and again, considerable amount of money (about 60 million USD) was allocated to the foundation and 50 percent of this allocation was with no back payment.

TTGV used this budget as an R&D fund for Industrial Technology Projects (ITP). Concurrently, a grant mechanism was also established by The Scientific and Technological Research Council of Turkey (TÜBİTAK, Turkish acronym), hence, TUBITAK and TTGV supports had become complementary and; as TUBITAK provided grants for R&D projects, TTGV had been giving supports on loan basis. Particularly among the years 2000 and 2010, the Turkish SMEs exceedingly used this model, which was a major source of external finance.

The ITP finished in 2006, and TTGV begun to use "Support and Price Stability Fund" (DFIF, as Turkish acronym) provided by Undersecretariat of Foreign Trade as well. Among 2006 and 2011, 75 percent of the loan provided to an eligible project came from these financial resources whereas the other 25 percent part was compensated from TTGV's own budget.

In this period, TTGV also generated several pilot implementations of new support mechanisms such as "Joint Technology Development Project" and "Commercialization Project" which were the outcomes of the report titled "An Assessment of the Industrial Technology Project-Final Report" by Taymaz (2006). They were the unique mechanisms, firstly measured in Turkey; however, their implementation by TTGV was not gone further from the pilot phase. Other agencies like KOSGEB and TUBITAK adopted them to their support schemes by implementing similar mechanisms to some extent.

As a model, we could claim that TTGV model has been successful in creating awareness for R&D and innovation, which had not been so commonly comprehended by the majority of the society in the 1990s. An IEG (Independent Evaluation Group) report (World Bank, 2006) concerning the World Bank activities in Turkey between 1993 and 2004 pointed out that two subsequent Technology Development Programmes of TTGV were rated as moderately successful and highly successful, respectively. Numerous studies have further claimed TTGV programmes have been successful in this context (Üçdoğruk, 2005; Taymaz, 2006; Özçelik and Taymaz, 2008).

4.3. A brief explanation of TTGV's R&D support mechanisms

TTGV has implemented different models of support mechanisms since its establishment. However, convenient to our purposes, we should briefly explain "Technology Development Projects Support", the major support programme providing R&D loans for industrial R&D in firms. Since almost all projects except one in our sample were supported under this support scheme, the detailed information about it willbe helpful for better understanding the data we use.

4.3.1. Technology Development Projects Support

In this support scheme, R&D loans (soft loans) were provided for industrial R&D projects. 50 percent of the project budget proposed by the applicant firm was subsidized in this context. The ratio of the support was fixed at 50% notwithstanding the technology base, firm size and forecasted effect of the project. The duration of the project was up to 24 months. Firms were obliged to pay back

the granted amount of money and the payback wouldstart one yearafterthe project was completed. The granted amount was repaid in three years period with seven instalments separated by six months between each. Firms used the soft loan on US dollars basis and the back payment of the firm was also on the same currency; thus, the applicant firm also undertook the exchange rate risk which had sometimes been a problem, particularly for SMEs, as proved by the several economic crises and macro economic instability especially around 1994 and 2001. The upper limit of the support was one million US dollars and this meant applicant firms were able to offer project budgets up to 2 million US dollars.[27] This amount was also referred as the R&D volume that was being created. 75 percent of the fund offered by TTGV was allocated by the Undersecretariat of Foreign Trade and 25 percent was compensated by the own resources of the foundation. On the eligibility evaluation of applicant projects, several academicians and private sector specialists, namely, Field Committee Members, were being utilized in order to evaluate the project proposal. The acceptance and refusal of the project in compliance with eligibility criteria was being determined by utilizing the definitions of Frascati and Oslo Manuals and by taking into account the current R&D ecosystem of the country. Thus, to be supported, it was not obliged to have radical or high tech innovations. TTGV could support incremental product and process innovations involving industrial R&D on international, national and even firm level. The only prerequisite being implemented was the necessity of capability building by the applicant firm with the comparison of its former and later capabilities; before and after the project being handled. For accepted ones in terms of eligibility criteria, one of the field committee members was charged as a "project viewer" to monitor the progress of the project and the assigned viewer usually made invaluable recommendations about technical aspects of it; hence, university-industry collaboration was being generated to some extent. At the end, technological know-how and intellectual property-if there exist, were left to the company performing the project. The

[27] Until 2008, this amount was sizable compared to the other R&D funding institution, TUBITAK. TUBITAK's grant programmes 1501 and 1507 were functioning in the same manner and within the similar limits. For 1507, TUBİTAK provided funds up to 400.000 TL for new R&D performers. For 1501, there was no upper limit, but the average budget size was very similar and generally those who submitted their projects to TUBITAK for being granted; they also applied for TTGV's soft loan.

commercialization ability of the project was also considered as eligibility criteria because the support was given on the loan basis and hence, it was an important issue for the support provider to get the provided money back. For this reason, TTGV could demand guarantee from the applicant firm for a determined ratio of the support varied in a range in accordance with the financial eligibility criteria. There was no interest but 6 percent of TTGV funding was chargedasservice fee, which could be declared as an interest or cost for the subsidized amount. This fee was being used to compensate the operational costs of TTGV in compliance with the issues determined in its establishment. Lastly, it should be noted that projects about investing in infrastructure or production in a plant or production line – even if it involves technology transfer - were not considered under the scope of this support. Its focus was only R&D activities.

4.3.2. Other Projects Supports of TTGV

There are also other mechanisms to support related activities in the scope of TTGV's mission. For example, "The Environmental Projects Support" is the only support programme within the National Innovation System of Turkey aiming to develop eco-innovation. In this context, R&D loans up to 1 million US dollars are provided for "Renewable Energy", "Energy Efficiency" and "Environmental Technologies" projects. Financial conditions of the support are same as Technology Development Projects Support Programme. TTGV is also operating in the field of risk capital and entrepreneurship under the name of Teknoloji Yatırım A.Ş. - a TTGV affiliated private company - investing in early start-up firms that have prospective technology intensive products for future growth.

The last support mechanism designated by TTGV is "Advanced Technology Projects Support Programme". The design of the programme is aimed at boosting the usage of Advanced Technologies in selected areas such as high value-added production of bio-products, advanced materials and precision manufacturing techniques, generation, storage and distribution of renewable energy, food technologies, biomedical technologies and technologies for adaptation to climate change. In addition to R&D focus of Technology Development Projects Supports,

this support mechanism has integrated commercialization part of the innovation to the subsidization phase and some infrastructure investment up to 20% of the project budget might be regarded as eligible only in the case of successful commercialization. Support amount is limited to 3 million US dollars with back payment as well. This mechanism is highly selective, choosing the projects with high multiplier factor to related industry. One project in our sample has been supported in the context of this programme.

In the subsequent sub-section, we particularly explain general statistics about Technology Development Projects Support mechanism of the foundation to have a general idea about how many projects was being supported and the amount of money that was provided in the activation period of this support scheme.

4.3.3. Technology Development Projects Programme and general statistics

Technology Development Projects Support was the major programme of TTGV, providing R&D loans for industrial technology development projects. It was sustained between 1991 (the establishment of TTGV) and 2011. It was the extension of completed "Technology Development Project" and "Industrial Technology Project" signed by the ruling Turkish government of that date and World Bank delegates as mentioned above. TTGV sustained the programme between 2006 and 2011 collaborating with the Undersecretariat of Foreign Trade and the details of the programme have been aforementioned in the previous section.

By the end of 2010, 2349 projects applied to the program and 938 projects weresupported within two decades. The ratio of supported projects in total applications was 39,9 percent. These numbers pointed out TTGV seriously examine the eligibility of applicant projects. SME ratio was about 77 percent and contracted amount had almost reached to 310 million US dollars. As the support amount was fixed at 50 % of the project budgetan R&D volume of almost 620 million USD was created.Table 5 provides these numbers in brief.

The last issue we should note is that the amount of support through TTGV lost its importance as other government organizations were assigned to role of supporting

R&D innovation. In Figure 6, we can see that even though the total amount of the TTGV support increased, its ratio in total R&D supports in Turkeydecreasedbecause TUBITAK and other governmental agencies have been takingthe initiative in the provision of R&D grants especially after 2005.

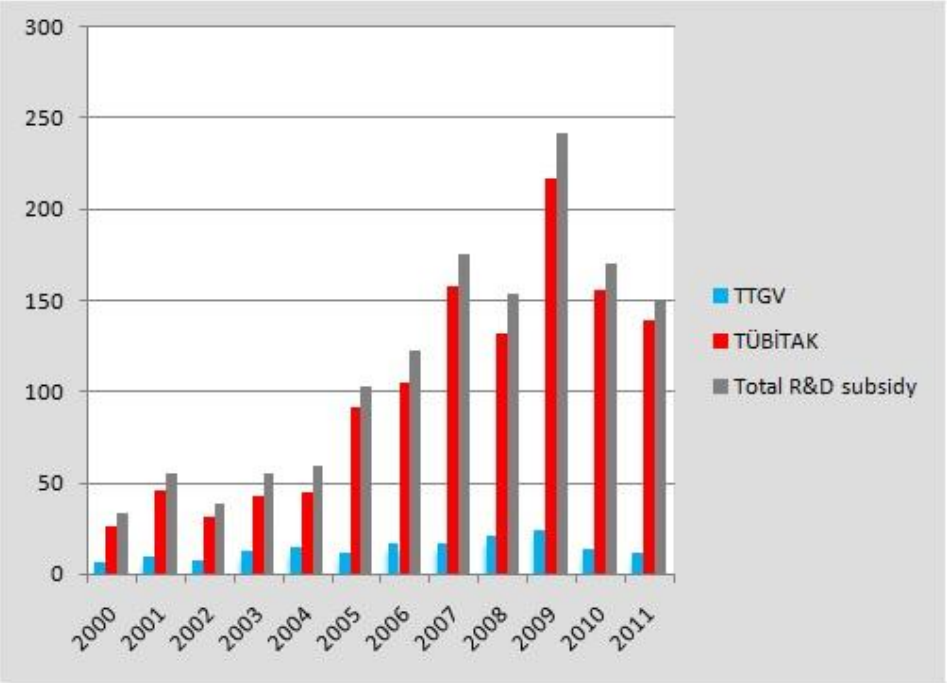

Figure 6 R&D loans, grants, value of supportedprojects between 2000 and 2011. [28]

[28]Values for TTGV are taken from TTGV Operation Programme 2012. Values for TUBITAK is available at:
http://www.tubitak.gov.tr/sites/default/files/tubitak_teydeb_destek_programlari_kapsaminda_gerceklesen_destek_kapsamina_alinan_ve_firmalara_verilen_hibe_destek_tutari.pdf

Table 5 Information about subsidized TTGV projects

Periods	*1992-1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*[29]	*TOTAL*
# of Applicant Projects	576	87	121	133	160	229	132	128	155	238	228	162	**7**	**2356**
# of Supported Projects	179	55	32	51	67	64	25	101	88	116	113	47	**3**	**941**
SME Ratio in Supported Projects	67%	83%	66%	81%	94%	78%	81%	87%	88%	88%	80%	86%	**33%**	**77%**
Contracted Fund (in million US dollars)	72	18,4	10	16,4	15,4	25,3	7,4	29,7	29,5	41,3	33.1	12,7	**6,9**	**318,1**
Total Project Budget (in million US dollars)	150,9	38,6	19,8	34	30,8	50,9	14,4	59,4	59	82,6	66.2	25,4	**13,8**	**645,8**
Provided Funds (in million US dollars)	47,1	7,2	9,6	7,4	12,9	14,9	11,9	17,3	17,6	21,3	24,8	14,2	**11,9**	**218,1**
# of Completed Projects	146	17	30	40	44	35	78	73	73	66	95	98	**96**	**891**
Back Payment (in million US dollars)	17,9	7,2	4	4,6	6,6	7,5	9,4	13,3	16,8	19,2	17,2	21,1	**19,8**	**164,6**

(Source: TTGV, 2012)

[29] The projects supported in 2011 belong to the Advanced Technology Development Programme. From this scheme, we have only one project in the sample.

4.4. The general characteristics of the R&D projects proposed to TTGV in the automotive industry

From the preceding discussions, one can deduce that TTGV representsTurkish R&D support experience because of its presence since the very beginning. Thus, in this dissertation, we assert that TTGV projects can be a good sample in order to analyze Turkish R&D (support) history in the automotive industry. We can state some of the main reasons of this selection as follows;

- The establishment of TTGV was also the start of Turkish industrial interest in global competitiveness through R&D, triggered by the export-oriented economic policies by the early 1980s.
- Despite the fact that TTGV provided loans with back payment, the support was highly desirable for industrial firms until the emergence of macro-economic stability in the Turkish economy by 2003. The supports were a point of attraction for industrial firms, particularly for SMEs, until the amount of provided grants increased, particularly by the R&D grant provision of TEYDEB (TUBITAK) and later by the provision of many other governmental institutions. However, until the end of the subsidization of TTGV, it is perceived that many of the big SMEs and JVs benefited from the funding programmes of the institution.
- TTGV has preserved its prestigious position; and being supported by TTGV has been a preferable occasion for industrial firms to prove themselves in R&D (almost used as a signalling device). So, we claim that TTGV is a good option forfirm that is interested inthe accreditation of its R&D activities.
- TTGV data might expose the evolution of Turkish R&D projects because it contains a 20 year-period of time full of R&D endeavours in the country. These endeavours have been changed and transformed into different forms with the expansion of R&D efforts throughout the industry. Thus, the data is capable of providing invaluable insights and a dynamic overview to R&D performed in Turkey.
- The evaluation, support and monitoring processes of TTGV's support programmes involve many noticeable points about the projects so that one

can easily understand the context of the R&D project. At first, TTGV brought a very detailed application form from the applicants. The information on it was further expanded with firm visits and field committee member reports. Then, the project expert was writing a detailed report based on these visits and opinions of the field committee members. Once the project was supported, it was monitored by the project viewer and expert. At the end, we have very detailed information about how the project was supported, evaluated and monitored; what was the innovative side of R&D in the project.[30]

- One of the fields that high numberof proposals received in the TTGV data is the Turkish Automotive Industry. Both with supported and unsupported project proposals it counts up to 102 projects, covering about 5 percent of all projects submitted to TTGV in 20-year period.[31] We assume this number is a critical mass.Not to mention that we work on the population.

With these reasons in mind, in this part of the chapter, we aim at analysing TTGV data concerning the automotive industry. The data has been obtained from the project proposals and factsheets of the field committee members, project viewers, expert reports and so on with an in-depth analysis of about 250 hours work.The data contains (unless missed or unavailable for the project context) information stated as follows:

- **The characteristics of the applying firms**: firm size, the composition of invested capital (domestic/foreigner), certification, location, R&D experience(R&D department, project experience), firms' field of activities and core businesses such as Original Equipment Manufacturer (OEM), Joint Venture (JV), supplier, subcontractor etc.,
- **The characteristics of the applied projects**: proposed budget, realized budget, project personnel number, the involvement of the design processes,

[30]All these factsheets have been read and evaluated while preparing the data used in this chapter.

[31] About 21 per cent of the projects were submitted under the mechanical engineering and machine industry projects; and we have selected almost 25 per cent of them in the context of automotive industry.

what type of innovation it involves (product/process), what is the level of innovation (firm, national, international), the product of the project (an intermediary or final product),

- **The value-added of the applied projects**: the technological field of the applied project, the unit cost and unit selling price of the project output (if it is process innovation, what is its contribution to firms' efficiency or market share etc.).
- **The market targets of the applied projects**; whether the product is to be sold out to OEM or supplier, is it exported or produced for domestic market, the market is new for the firm or not, what is the expected compensation period for the project investment.

Given the obtained data, we find out general trends and facts about the Turkish automotive projects and about their performers. We further explain in which technological field Turkish automotive R&D projects have been intensified and whether this field is traditional or contemporary. We also put forward this discussion into a new dimension by adding up the concept of technological sophistication. The argument is simple: if the technological sophistication of the R&D projects is not increasing in time, it may mean that the Turkish Automotive Industry faces a mid-tech trap. For this reason, we classify the projects and their technological fields systematically to investigate this simple assertion.

We begin by the general information about the R&D projects of TTGV in the automotive industry. We present our data in the following section.

4.4.1. The general information about the sample

From every field of technology, there are about 2300 projects in the TTGV database. About 21 percent of them belong to machine industry, 27 percent of them is about electrics, electronics and software development, 13 per cent of them is on the field of chemical industry and finally, 17 percent of them is on the technological area of materials engineering.[32] At first, we have selected the projects related to machine industry covering about a sample of 500 projects. Later, we have made one

[32] About 22 percent of the projects belong to other technological areas.

more selection including the separation of automotive related projects from those of machines related. Then, we have 102 projects left. Since some of them have missing information in their proposal files or reports (especially the earlier ones), we have 86 projects left to examine in our sample.

The projects are related to the different parts of the automotive value-chain. They have different types of performers Multi-National Enterprises (MNEs), SMEs, JVs etc. Some of them were not supported by TTGV due to some missing elements of the eligibility criteria. Some of them aimed at creating product innovation while others' focus was process. Some of them proposed value-added in their products while some of them tried to combine productivity change with efficiency. Grouping these different kinds of projects has required a hard work.

To achieve this aim, we firstly group required data according to the project proposal and development phase. The first main column is about the applicant firm's general information called *firm data*. In the second main column, we have gathered information about the project proposal, called *project proposal data*. Since every applicant firm should introduce their firm information and the details of the project proposal, it is quite easy to gather the information concerning these two sections. In the last main column called *realized data section*, we have tried to obtain project results. However, in this part, despite the fact that we have benefited from the project final reports both from the project reviewer and firm, it is hard to gather this information since the results of R&D projects requires a time lag in order to clearly understand its micro effects on the performer. Moreover, there is also missing information concerning the projects being withdrawn because the financial consensus between the firm and TTGV could not have been handled. Thus, the information we have tried to obtain in the last column about realized data was highly incomplete and less reliable.The details of the collected data can be found below.

- In the '**firm data section**', it covers the information about the applicant firm such as the number of workers, if there exist any R&D department, the financial structure of the firm (national or foreign capital), the national

origin of the firm, the location, if the firm has international certificates (to have an opinion for the firm's international adaptability), if there exist any R&D projects performed by the firm and firm's field of activity (core business).

- The '**project proposal data section**' covers data about the proposed project such as the number of workers recruited in the project, if the project involves R&D design or not (if so, the know-how is from OEM or the firm makes the design process), if the project involves product or process innovation; if it involves firm-based, national or international level of innovation; if it is product innovation, it is intermediary or a final product, to which component in a car it is related[33], the type of customer (JV, OEM, 1st, 2nd, 3rd tier supplier or last user), the location of the customer (in/abroad), the target customer of the product (home or domestic market), unit cost of the product, unit price of the product, the value-added per unit, the compensation period of the project and finally, if the product is for a existing market or it creates a new market for the performer. Note that, since this section data are taken from the project proposal, they also show the expectation of the firms at the very start of the project.
- In the '**realization data section**', we examined what happened after the project. But as stated in the above discussion, even by utilizing the final reports, we could not reach sufficient amount of data concerned. Those data involves what was the duration of the project[34], what was the realized budget[35], whether the project was accomplished, if the project output was commercialized and what was the origin of the customer. Except the first two data, these data required additional connection with performer firm. It is very hard to obtain these data especially from the firms which was not

[33] The details of the partition of automobile components could be seen in Appendix A.

[34] This might be differing from the project proposal. The R&D supporting scheme of TTGV has allowed the firms to expand project duration with some limits.

[35] Since this is a R&D project, it is very common that the planned budget differs in the realization period. There have been different concerns of project performers while performing the project. One should note that because of the limits of the supporting scheme, no realized budget could have been passed the amount approved by TTGV Board.

supported or withdrew its project for several reasons. Thus, we have just taken the first two data, namely project duration and realized budget, from this section due the data limitations discussed above.

4.4.2 Firm data section

In this section, to analyze the overall data we begin firstly by the firm characteristics. We firstly introduce the number of employees' data dividing the firms into two sub-groups; and with reference to the SME Act we take 250 employees as benchmark.[36] According to this; 52 of the performers had personnel number under 250 when they had proposed their R&D projects.

In order to examine the applicant firms R&D affinity, we have also checked whether they have an R&D department or not. In this part, we assume that even there is one registered person working as R&D personel in separate R&D department we suppose that the firm has an R&D department.From examination of project proposals, we have found that 57 of 86 firms had R&D departments as they applied for the project support.

For investigating the applicant firms' capital formation, we divide the firms into three parts: domestic capital, foreign capital and foreign-domestic partnership (joint-ventures included). From this division, we have found out that most of the projects (73 of them) had domestic owner at the time of the application. There had been 9 applications made by foreign domestic partnerships while only three projects had completely foreign capital origin. One can deduce that most of the R&D efforts have been pursued by domestics firms with domestic capital structure.[37]

For the origins (nationality) of the firms, we examine the capital formations according to the nationality of the investor. From the examination, in addition to 73 firms of Turkish origin, we found that two Holland and one German firm while

[36] SME Public Act (2012)-please note that the budget size is not a concern for us in this part of the study.

[37] It is to be investigated in firm cases in Chapter 5 as well.

there had been 9 domestic-foreign partnerships including 3 Turkish-American, 3 Turkish-Italian, 2 Turkish-French and one Turkish-Flemish origins (Table 6).

The locations of the applicant firms are rather clustered in the Marmara region. Particularly, 50 of the projects was expectedly located in Doğu Marmara Region composed of Tekirdağ, İstanbul, Gebze/İzmit and Bursa. İzmir, Konya and Eskişehir seems as other locations with intensified numbers of project proposals (Table 7).

Table 6 Applicant firms by national origins

Applicant's national origin	**Number of firms in sample**
Turkish	73
Turkish-Italian	3
Turkish-American	3
Flemish	2
Turkish-French	2
German	1
Turkish-Flemish	1
Info NA*	1

(*NA=not available)

Table 7 Applicant firms by location

City	**Number of Project proposals**
Bursa	21
İstanbul	14
Gebze/İzmit	12
İzmir	11
Konya	8
Eskişehir	7
Ankara	3
Tekirdağ	3
Adana	3
Manisa	2
Aydın	1

In the automotive industry, certification is almost necessary to sell the products or to procure goods to the OEMs, JVs or MNEs. In Turkey, the structure is formed by many subcontractors surrounded around an OEM or MNE that is generally a joint-venture with a domestic affiliate. With this reason, it is expected that subcontractors, 2nd and 3rd tier suppliers should have certificates so that they can procure to tiers of the upper levels. Given our findings, we have come to the conclusion that majority of the R&D performers (67 out of 86) having applied to TTGV for project support, have some certificates such as ISO 9001, ISO 16949, Ford Q1 etc (at least one of diverse certificates).Particularly in the projects of the earlier period (3 projects in the sample), there was no information about certification so in fact 67 out of 83 firms have certification.

In order to measure the firms' R&D tendency, we also control whether they have performed R&D projects before having applied to TTGV. In our sample, there are 61 project proposals in which their performers involved in R&D projects before they had introduced their project proposals to TTGV. There are only 16 firms that had never been involved in R&D activities until their TTGV project proposal. One can claim that the project proposer firms at least had made an R&D project and they had started their affinity with R&D before their application for the TTGV support. But of course, we cannot say much regarding the quality of their previous R&D attempts.

Furthermore, core businesses of the project applicants are divided into four categoriesas follows:

1) OEMs and JVs
2) Auto-suppliers
3) Engineering and consulting firms
4) Firms having core business different than automotive industry.

When we divide the project owners into these categories, expectedly auto-suppliers have taken the majority. 53 of 86 projects belong to this group of firms. In addition, there are 19 OEM-proposed R&D projects while engineering and consulting firms

proposed 8 projects. There are only 6 projects that the performers are not active in the automotive industry as their core business (Figure 7).

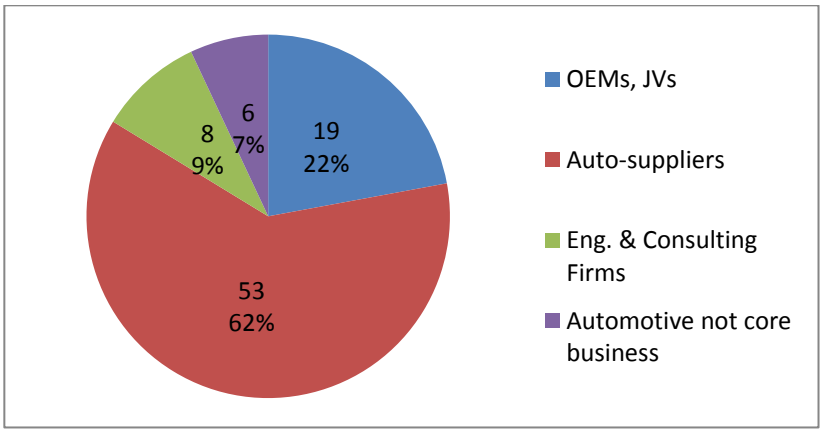

Figure 7 Project proposers by their core businesses

To conclude this sub-section, for the applicant firms, we can say that almost half of the firms are big enterprises; the data shows that generally firms with personnel numbers 30 and above had applied for the R&D projects. This might well be a sectoral sign for the lower limit of performing R&D. Moreover, our data shows that project proposers generally had affinity to R&D activities and evenhad an R&D department before applying to TTGV for the support. They have been also certified at least with one certificate in different types (ISO, CE, Q1 etc.); thus one can reasonably argue that they had some affinity indoing business internationally. Above %50 of the firms that had proposed R&D projects, were located in Doğu Marmara cluster which is the most renowned auto-cluster in Turkey.Finally, most applicants are Turkish firms and the share of foreign capital is considerably low. Particularly, joint-ventures and foreign affiliates have foreign direct investment on their own brand.

4.4.3. Project Proposal Section

In this sub-section, we have collected data about the project proposal details concerning the project personnel, its innovative character, its technological field,

target customers for the project output, its expected compensation period and finally, its expected value-added.

To begin with project team, it has been determined that number of project team members could vary from 4 to 96 depending on the project and performer type. For example, OEMs and JVs have performed projects with high number of personnel as expected. In addition to project team numbers, man/month ratio[38]varies as well from 0,25 to 15,25. These findings are solely preliminary and one should be careful for quick deductions.

As generally accepted, modelling, design, design verification is an important part of the R&D activities (and mostly the part that brings the highest value-added). In our sample, we examine each project file in detail and found out if there exists any kind of such activities in the projects. According to this examination, we divide our sample into three parts. The first part of the projects involves modelling, design and design verification processes in which the performer firm did not take any assistance, technology transfer and know-how from other firms (particularly from OEMs and JVs) and it performed this kind of activities in isolation in terms of vertical relationships. In the second part, we have grouped the projects which have know-how, data, specs or technology transfer from the upper tier (from OEM, JV or 1er tier) so in a sense involving vertical relationships. In the last group, we have collected the projects which have not considerable design process. We should also note that in this part, "design" also involves the efforts for creating process innovation. We do not limitourselves solely in product innovation.

From this grouping, we come to the conclusion that 58 of the projects are in the first group. 25 of them are in the second one. Mostly, OEM branches located in Turkey or their subcontractors used this method by taking the specs, data, know-how from the main branch or related OEM. This may have positive as well as negative connotations. The positive one is that it is considered that there was a knowledge transfer from OEM and JV (or global network) to the subcontractor. The negative

[38] Frascati definition

one is that Turkish manufacturers and subcontractors are dependent on the OEM, JV or contractor being vertically related.

One of the basic issues in R&D project evaluation is to find out whether it involves product or process innovation, or both[39]. Product innovation is defined for newly produced products or products that have considerable innovation on its functionality, purpose or quality. Process innovation can be defined as a new way of doing things in a more efficient way or in a better quality (see Chapter 2 for definitions). It provides time, money, revenue, reputation to the performer firm. Sometimes, project requirements may pose that an R&D project might contain both types of innovation. In this part of the study, we have grouped our sample according to these definitions. From the data we observe that,there are 57 projects related to product innovation while 13 of them possessing only process innovation and 16 of them involving both type in one single project. The conclusion explicates that our sample of R&D project proposals are, to a great extent, related to product innovation.

In the evaluation process of the project proposals, one of the basic issues is to determine the innovation level of the project. A project has been classified into three levels of innovation it proposed: firm-based, national and international. Firm-based innovation can be defined as an incremental one which is towards enhancing firm capabilities or products; however, it is not an innovation at national or international frontier. The innovation at the national level can be described as the first attempt of creating something new that have not been performedyet in the national industry. Finally, international level of innovation proposes something new for the world. Here, note that it does not solely mean a radical innovation; in another aspect, it might offer a novel innovation that is not being made in another country. Generally, it is assumed that radical innovations have the potential to boost economic performance rather compared to incremental innovations. Also note that, in order to widen R&D culture throughout the nation, in the first 15 year-period of R&D supports, institutions being responsible for introducing R&D supports,

[39] One of the critical points in project evaluation process is to determine the innovative side of the project. Unless there is innovation, the project has no opportunity to be funded.

provided loans or grants to the R&D performers, generally supporting firm-based innovations in their projects.

From the data we obtained, we have determined 30 firm-based, 51 national and only 5 international level of innovations. Three of the international level innovations belong to OEMs or JVs while one of them belongs to an engineering and consulting firm and one is for a novel process innovation in a subcontractor. If we look at the OEM and JV projects, one of them is a novel bus design involving design functionality for user-purposes. The other two are projects made for main branch in order to compensate the regulations of the European Union. From these examples, one might deduce that even international innovations in our sample are not radical innovations having more potential to boost economic performance of the project proposers.

One of the critical issues to examine in the dissertation is the subject of the projects in the sample. What are the major R&D concerns in the projects? The answer to this question is of importance since the critical value of the projects is related to their technological complexity and creativity. According to the general assumption, contemporary and generic technologies promise the critical core of the sectors or industries and thus, the sources of value-added. We examine that whether in Turkey, the research and development are sustained through such kind of contemporary technologies or they are about the traditional technologies or components in the automotive industry. To attain this aim, we firstly used a classification made by a group of scholars[40] and thus, divided an automobile into its sub-components. The main groups can be stated as body, body equipments, electric and electronical components, safety components, engine, power-transmission and some emerging technologies including recyclibility and telematics. In this classification, the areas promising more technological complexity, creativity and more value-added is about the projects in electric and electronical components, safety components and engine while power transmission, body and body

[40] This is an unpublished study made by a group of academicians with the leadership of Tülay Akarsoy Altay, in order to divide an automobile into its subcomponents. You can find this grouping of automobile components in Appendix A.

equipments involve more mature and traditional technologies in the automotive industry. It should also be noted that a considerable number of projects involves the development of a car, bus or tractorheavy vehicles, construction vehicles etc. In these projects, we mainly examine the core part of the project and what kind of activities the performer made in the projectsin order to have a broader perspective. We group them under the name of "vehicle".Lastly, there is the final group called "others" that involves the projects including moulding, process developing, equipment producing etc.

This grouping clearly shows us that exactly half of the projects are in more traditional parts as body, body equipments and power transmission. Only 8 of the projects in a total number of 86 are in more generic and contemporary fields like electrical and electronic components, safety and engine. This finding supports the claim that Turkish Automotive Industry is not able to move up the ladder in contemporary technologies, such as electrical, electronical and control parts of the automobile globally developed particularly after 1980s. Furthermore, Turkey has not been able to developits know-how in engines which is the most critical part of an automobile. Moreover, generic fields like telematics and recyclibility have not been an R&D concern of industry yet (Table 8).

Table 8 Projects in terms of auto-component classification[41]

Auto-Component	**No. of projects proposed**
Body	23
Power-transmission components	13
Body Equipment	7
Engine	6
Electric/Electronic components	1
Safety Components	1
Telematics, Recyclibality	0
Vehicle	16
Others	20

[41] As to be stated in the other chapters, for example, some parts related to body may involve state-of-the-art technologies such as composite materials. The use of Magnesium and Aluminium is a hot topic to decrease the weight of cars for lower fuel consumption as a future trend. But here, we should state that each project has been examined deeply not to overcome this fact. However, we have not run into such kind of technological concern in R&D project of the concerned data. A reader should be confident about each project has been examined and classified in this sense not to make a mistake.

In complete vehicle projects, mostly engines and sensitive manufactured components having one of the most value-added aspects in an automobile, had been procured from a global manufacturer. In 15 of 16 of that kind of projects, engines had been procured from a global manufacturer. The exception was only one project which was about tractor manufacturing in which the project proposer is an engine manufacturer which is rarely found in Turkey. In developing more contemporary cars like hybrid and electrical, the situation is not very different. One of the projects was about manufacturing a hybrid car but, in the project, we have also seen that the manufacturer procured critical engine and hybrid components(electrically intensive technologies) from abroad. One final exception is an engineering firm that is developing electrical car components recently.[42] This project is being supported in the context of Advanced Technology Support Program and in that project, the firm aims at developing its unique and novel designs.

Some of the critical questionsposed during the examinations of the TTGV are about the output of the project. Those questions involve "where will the output be used?", "what is the location of the market? (domestic or abroad)", "what is the compensation period for the project (R&D investment)?", "Does this output provide a new market or is it for an existing market?", "what is the value-added being created by an unit output?" etc. From these questions, we have discovered the market characteristics of research and development efforts in the proposed projects.

For the first question, we have classified the possible usage of an output into four groups. In this context, OEMs, JVs, subcontractors and last users can be possible customers of the project. In addition, performer firm may possibly use it both in its products and/or in its processes as well. Our sample of data clearly exhibits outputs of 50 projects that target OEMs and JVs as their customers. 17 of the project

[42] It is the last project of the sample that is actually being supported by TTGV. The start of the project was at the beginning of the year, 2012.

outputs were for subcontractors and procurers.[43] 19 of the projects were for the last users. Those projects are mainly about producing a vehicle. Finally in 10 of the projects, the firm aimed at developing product or process for its own usage. With its weight on OEMs and JVs, this composition of groupings for project output refers that in Turkey, R&D projects are majorly being ignited by global manufacturers and OEMs and this might be a supporting argument on Turkish one-sided dependence on the global automotive industry. One can also claim that the ruling existence of OEMs and JVs in design processes can also be verified by this fact (Figure 8).

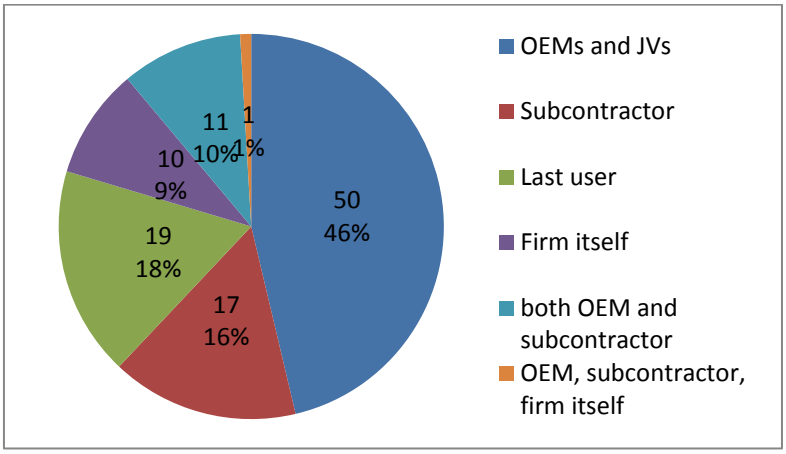

Figure 8 Projects by customers

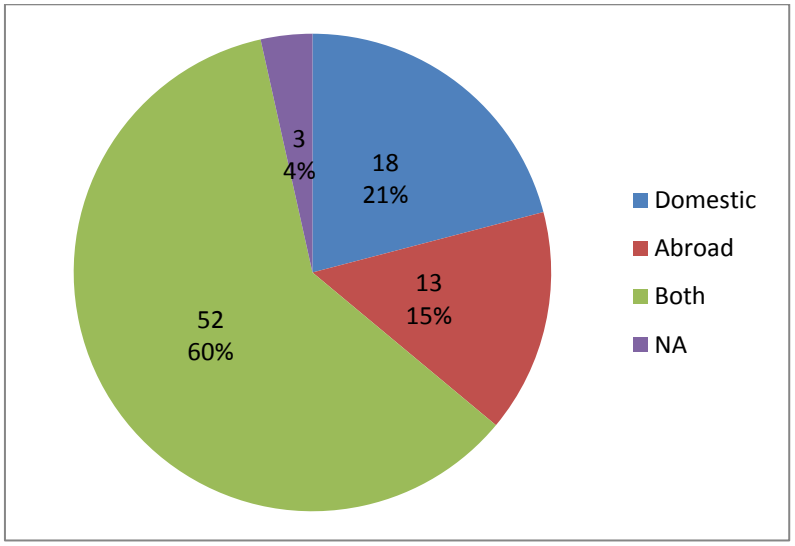

Figure 9 Projects by market orientation

[43] Here please note that there are 11 projects having outputs both for OEMs, JVs and subcontractors (1er tier, 2nd tier, 3rd tier etc.)

For the second question, we use our sample to determine the general market motivation behind the R&D efforts. In this context, we divide the projects into three groups. The firm can possibly sell its R&D output to domestic market, abroad and both of them. As we analyse the sample, we recognised that there were three projects in the sample which had been made for the firms' own purposes and so, they could not have been put under this classification. 52 of 83 projects were for both domestic and abroad markets. 18 projects were only for domestic market while 13 of them are solely for the abroad (Figure 9). This figure shows that R&D performers in our sample generally focuson both domestic and international markets. 65 projects in our sample have more or less export motivation under its R&D efforts. One can conclude that one of the main motivations of R&D in Turkey is due to the export tendency of the performers. The evolution in this export tendency is also important so that we can see the competitiveness provided by R&D as expected in the subsequent part explaining the dynamics of the projects.

The third question is about the compensation period referring to the compensation duration of the project budgets in the context of the expected outcome from their commercialized output or from their benefits of the process they provided. The project budget has been divided by the profit expected from the project output. From this calculation, 50% of the projects seemed to be compensated by its output in one year or less. Nearly 25% of the projects were compensated in the duration between one or three year. Only five projects had a compensation period of more than 3 years. There are 16 projects that we could not have calculated this period due to data unavailability or inappropriateness for the project context. From those calculations, one can argue that proposed projects have an expectation of short-term returns. This shows us two facts related to the projects. The first one is they did not involve radical innovations. They generally involve incremental innovations. The second one is that they did not contain R&D efforts with high level of complexity

(at the world frontier).[44] This finding suits with our findings regarding the technological fields of the projects.

In order to understand the market focus of the projects, we categorize the projects according to their potential of new market creation for the performer firms. In this context, a project can either create a new market for the performer or it is for the market in which the performer exists. In the second case, it means that the firm has realized a product improvement or process innovation having no potential to create a new market. We found that 57 of the 86 projects were for new markets while 29 of them were for the existing one. This indicator on its own of course will not mean much however; it is still a promising result about the creativity of innovations in our data set.

The second important issue in the projects that has new market focus is their 'degree of focus'. Withthe 'degree of focus', we refer that if this new market is at the firm level, national level or OEM (JV) level. For deepening our analysis and questioning whether the innovations contain creativity, we use this categorization. From our data, we found that 44 out of 57 projects solely created new markets at the firm level. This means that there was an existing market in which the firm was already operating and after having performed the project, the firm was able to penetrate to the market. 6 of the projects were at national level while 7 of them were at the OEM level. This refers that output of six projects would create a new market at national level. Moreover, seven of them would provide a new market for the OEMs operating globally. From this perspective only seven of the projects would be expected to be effective at the global level. This confirms that projects in our sampledo not involve radical innovations.[45]

[44] Here please note that because of the project proposal limitation of TTGV; those projects could not have contained project budgets more than 2.000.000 US dollars.

[45] The last question about the value-added is not analysed in this study because of three reasons: The first one is, practically there are wide range of project subjects and it is too difficult to classify the information about value-added because of this wide operating spectrum. The second reason is the properties of global automotive structure. From the interviews in the context of this dissertation, we reached an invaluable information that there is well-established and rigid value chain in auto industry and value-added and profit rates are already determined by MNEs. This point is to be outlined in Chapter 6. Lastly, the information requested from JVs via OSD in Turkey was not admitted by any

4.4.4. Realization of the project section

As stated in preceding discussions, there have been two viable indicators from this section of the data: realized time and budget of the project. First of all, we should take into attention that in terms of TTGV support programme, namely Technology Development Projects Support, firms only could propose the projects within the duration up to 24 months. In addition, the upper budget limits are 2.000.000 USD dollars. Within those limits, the general tendency of project durations is between 12-18 months and the realized project budgets are between 500.000 -1.000.000 USD dollars. Not all the projects in our sample have information about their results. For this reason, we do not present further details regarding this information.[46]

4.5. The dynamics of technological sophistication and market orientation in proposed projects

As mentioned in the beginning, throughout this chapter, we are searching for the dynamics of technological sophistication in Turkish automotive R&D projects. The hypothesis is simple; if the technological sophistication of the projects has become diversified, widened and deepened in this period between 1991 and 2011, one might argue that Turkish R&D efforts has been accomplished some success, reaching near to a critical threshold to take a level up. However, at first, we should clearly define what we mean by technological sophistication in the automotive industry.

> Technological sophistication can be defined as *a state where* technologies depend on novel R&D projects that involve high value-added, aim at attaining higher level of innovation within contemporary technologies of the automotive industry, and that are based upon design intensive products/processes without depending upon OEMs as customers or know-how providers.

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of the JVs (for this petition, see Appendix A) and thus, we have no possibility to benchmark our findings about the value-added with any other data. As a result, value-added analysis has been omitted from the study and a dynamic measurement of technological sophistication in R&D projects is to be proposed instead.

[46]This part is not appreciated as important for our analysis in succeeding sections.

Here, the central question is which indicators might be helpful for us to test our hypothesis in accordance with the definition of technological sophistication. To answer this question, we basically select some indicators from our sample and try to measure their change in a timeframe.Since there is not a similar study in the literature, we should draw a novel framework for achieving our goal.

From the data in the preceding section, we chose eight indicators and investigate the evolution of the indicators in three time periods. We argue that this investigation will give the first clues about technological sophistication in the automotive industry. Our understanding and from the experiences of project application evaluation, the determined indicators are *innovation level*, *technological field*, *market orientation, design intensivity and OEM presence, innovation type*, *customers of project outputs*, *compensation period* and *R&D complexity* of the projects.

Technological sophistication increases when R&D efforts become more complex through time in the sense that the R&D and innovation activities are more at the world frontier in contemporary technologies. Sophistication also refers to a more design intensive process in R&D; an independent decision making in R&D and innovation and a self-sustained position where the firms can easily penetrate in to sophisticatedinternational markets.

Thus, the main hypothesis of the thesis is that the technological sophistication level of the R&D activities in theTurkish Automotive Industry has been stable over the years.

The main indicators are explained below in detail.

Innovation level: We use the innovation level indicator in order to measure the technological creativity of the project. As determined in the data section, R&D involved in the project can be in three levels: firm, national and international level. It is clear that for R&D projects, having international level of innovation signals high level of creativity or high level of technological complexity or both, in the design or technology related to the project whereas firm level of innovation, in

contrast, involves only incremental innovations within the products or processes specific to firms. Thus, we should perceive the transition from firm level innovation to national level and national level to international level as a positive sign in the project context in terms of creativity and technological complexity.[47]

Technological field: As being classified in the data section, we have separated a car in more than six basic parts[48] and over 80 sub-parts by taking related fields of the projects from the proposals (see Appendix A, Table 8 and section 4.4.3.). In this context, three of the parts are in more contemporary technologies like electrical and electronic components, safety and engine whereas the others are more traditional ones, namely body, body equipments and power transmission. We also put the vehicle production to the contemporary fields by assuming that they involve high level of technological complexity compared to single, traditional parts.[49]Given these assumptions, we can hypothesize that there should be an evolution from traditional fields to contemporary fields to say that the technological sophistication has increased.[50]

Market orientation: R&D is useful for firms to gain competitiveness over their competitors in the industry. Industrial competitiveness provides nation more income and wealth (Porter, 1990). One of the most considerable sign of competitiveness is the capability to export a product, process or know-how in international markets. Despite the limitations due to our data, we check this by exploring the export tendency of the projects. By comparing selected periods in the selected timeframe,

[47] Note that innovation level has been reflected from the reports of field committee members for each project.

[48] Here excluding 'other' part.

[49] Note that each project file has been examined and the separation between traditional and contemporary technologies has been achieved not only by specifying the technology area but also by examining the quality of performed R&D operations within the project. For example, for the body part, current technologies are offering magnesium alloys suggest a more contemporary field of technology. In this context, C (contemporary) or T (traditional) has been given to projects by analysing the whole context of the project proposal rather than simply assuming that the research and development performed for the body parts is surely about traditional field of automotive technologies.

[50] Technological field of the projects have been taken by not only respecting the firm's declaration in project proposal; but also by self examining the project subject and files.

the increase of the number of projectswithan export tendency is assumed as the increase of export capability of the project outputs.[51]

Design intensivity: R&D activities are supposed to have design processes to provide more value-added to the performed project. As argued earlier, design and design confirmation processes are considered as significant, validating the quality of R&D activity. From our sample, we collect the data, providing the existence or non-existence of design processes within R&D activities. We divide projects into three parts; namely, design existent, specs from OEM and design non-existent. To briefly define, design existent refers that there is a collected series of activities related to design and design confirmation process. Specs from OEM means, in the project, there are designing activities but these activities are held by obtaining know-how and considerable data from the OEM to whom the performer procures. Lastly, design non-existent means that the projects have no design intensive activities. Here, the existence of design within the R&D project is prescribed from the propositions of performer firms and approved by the field committee members. For technological sophistication, we search for design intensive projects not dependent upon OEMs.

Innovation type: Innovation type of R&D projects might be a clue to understand the evolution of technology in a selected industry. As mentioned, process innovations are considered as a trigger of productivity increase whereas product innovations are a good sign of increasing market share. Turkish industry has gained its momentum in exports by augmenting its productivity rather than entering the markets with different and varied products.[52]For this reason, we assume that, to test whether technological sophistication level has increased, product innovations are more important in comparison by regarding their inheritance of design, creativity and representation of new ideas. If there is an ongoing transformation in the industry

[51] Due to limitations being realized after the project was terminated, the firm declarations have been taken as essential as we determine whether there is a probability to export or not after the termination.

[52] This argument is to be offered by experts in Chapter 6,

towards product innovations we assume a positive sign towards sophistication of R&D projects.[53]

Customers of the project outputs: The successful outputs of the R&D projects are considered a vital element to sustain the R&D performance. It is definitely desired that innovative outputs are introduced to sophisticated markets to obtain a higher value-added. In the Turkish case the reliance on OEMs is an important issue to discuss and analysing the change in attitude over time may give us a clue about how dependent Turkish firms are on the foreignfirms and whether this changes over time. Being connectedto (and dependent on)OEMs and JVs rather than diversifying marketsis an impediment to be surpassed by the Turkish Industry.We hypothesize that the decrease in the number OEM and JV as customers is a good sign towards sophistication of R&D projects.

Compensation period: The compensation period of costs incurred in the R&D project is preferred as short as possible; and certainly, the benefit represented by an R&D project to its performer firm is related to its uniqueness, novelty and sophistication. As we assume, examining the proposed compensation periods of projects in our sample is a useful way to investigate this. Calculation of the difference between varied compensation periods through time may also give some evidence about the sophistication of R&D. We simply hypothesize that decreased compensation periods in selected R&D projects may offer a tendency towards sophistication of projects.[54]

R&D complexity: More complex R&D activities – with more budget and personnel – are a sign of inclination towards more systematic and sophisticated R&D. We use budget and personnel numbers to come up with a simple measure. Due to the limitation that there is an upper limit in a proposed budget of TTGV projects, we add up the parameters of proposed personnel number and project duration for the

[53] Innovation type has been acquired from the reports of field committee members.

[54] The compensation periods are taken from project proposals and belonged to the foresighted measures of project owners. Unfortunately, it is impossible to measure their reliance whereas there has been no evaluation of such kind done throughout the project monitoring periodstarted after the projects had been terminated.

given R&D project and by measuring the budget per project and the personnel number/month ratio per project, we attaintwo sub-indicators for consequent time periods. Ifbudget or personnel per month number increase among different periods, we assume that there is a tendency for increase in the complexity of the R&D activities in a selected project.

All the indicators discussed above are equally significant for determining the trend for technological sophistication in the R&D projects. We further build up our discussion upon these indicators as we interview with experts and firms in our additional exploratory researches that follows in Chapters 5 and 6.

4.5.1. How to measure the dynamics of indicators

At the very first, we should state that by saying *dynamics*, we mean to measure the change between different time periods. So the important issue is how we divide the sample into meaningful periods and what is the rationale behind this division?

To answer this question, we propose that the evolution of supports and industry might be a good basis. As noted earlier, the year of 1991 was the beginning of the story and 1990s might be perceived as the adoption period of awareness to the terms 'R&D' and 'R&D' incentives. The fact that science, technology and innovation are path-dependent, cultural and cumulative processes; calls into the question that, in a society, a change in the awareness and perception of R&D could come into existence as time passes by. At the beginning of 2000s, to our understanding, we observed that Turkey went into a different state of R&D consciousness particularly after the crisis of 2001. By the beginning of 2003, Turkish economic situation also changed positively with high growth rates until the global crisis of the year 2008. Turkey recovered from this crisis rather fast compared to other countries but the growth performance in the recent years has not provided yet the same growth performancebetween 2002 and 2007. Another point to be mentioned is that especially after 2002, R&D supports provided by the government,particularly assigning new roles to TUBITAK, has speeded up and after 2008, these supports have been provided by utilizing different mechanisms offered by different governmental agencies. On behalf of TTGV, the loaned amounts also augmented in

this period, making a peak between 2007 and 2009. To conclude, with this socio-economic and political background, we have divided this 20-year period into three sub-periods:

1) 1991-2002 (awareness for R&D),
2) 2003-2007 (expansion of the R&D supports throughout the industry),
3) 2008-2011 (diversification of R&D and their supports).

Moreover we should measure diversification of the projects in terms of their technological fields and indicators and compare them with each other through different time periods. It is also quite an important issue for us to see the tendency and evolution of diversification of technological fields and the indicators in the timeframe we have periodically separated. Here, the central question is how can we measure this?

We begin by diversification. We classify the projects According to their technological and sub-technological fields within the selected time periods.[55] With a simple measurement, we calculate the diversification rating given in Table 10 by utilizing the formula below:

$$r = \frac{s}{n}$$

where;

r=diversification rating

s=number of sub-technological fields concerned in performing R&D in a given project

n= the number of project sample in the given period of time.

[55]Technological and sub-technological fields have been separeted according to the classification given in Appendix A. Technological fields represents the fields in the headings of the Table in Appendix A while sub-technological fields are the detailed parts in a given technological field.

On behalf of indicators, we first divide the indicator into sub-indicators and we offer a simple model based on the percentage differences of sub-indicators in the subsequent time periods. Firstly, by mentioning sub-indicators, we refer the sub-components of the indicators. For example, the indicator of innovation level is composed of firm level, national and international level of innovation taken from the project reports of the field committee members. This discrimination was helpful in evaluating the creative value of R&D effort in a given project and it was highly decisive in supporting the project. Similar to this case, the sub-indicators that we use to test our hypothesis are given in Table 11 for every indicator. This gives us an opportunity to compare different sub-indicators with each other to comment ontechnological sophistication. This is simply given in Table 12. One final thing to discuss further is the eighth indicator, namely, R&D complexity. We measure it in a little bit different way by involving the data we have at hand. We use proposed project budget, charged personnel number and realized project duration for a calculation to have an opinion about the complexity of R&D processes in a given project.

In accordance with these explanations, the general formulations can be given as follows. For the first seven indicators, percentage shares given in Table 11 are the same and can be formulised as;

$$p = \frac{x}{n}$$

where;

p= percentage share of project numbers belonged to a given sub-indicator in a given period of time,

x= the number of projects related to given sub-indicator,

n= the number of projectsin the given period of time.

For example, for the indicator of innovation level, we expect the sub-indicator of international level of innovation increases faster than the other ones. We make this

comment by comparing the percentage change of each sub-indicator in subsequent time periods.

For the eighth indicator, the calculation is little bit more complex. There are two sub-indicators calculated similarly. Here, it refers that if c_x increases; it means cumulative R&D complexity of the projects increases:

$$c_1 = \frac{p}{m.z}$$

$$c_2 = \frac{b}{m.z}$$

where;

c_x= R&D complexity rating,

b= proposed project budget,

p= charged personnel for the project,

m= realized project duration,

z= number of projects having all the values present in the sample to be calculated.[56]

Now, we are ready to represent the findings from our data.

4.5.2. Findings from the measurements

Given the explanations above, now we should turn our attention to the analysis and findings. In Table 9, we give the project numbers year by year in absolute numbersby different indicators. In Table 10, we present the diversification of the projects in technological fields. In Table 11, we deploy the indicator and sub-indicator values and their percentage shares in a selected period to completeframework.[57]

[56] Due to missing data, z values are 14, 23 and 23, respectively for the subsequent periods.

[57] In Table 9, you can find sub-indicators year by year in absolute numbers.

The striking point in Table 9 is thatincrease in absolute project numbers by years. Particularly, by the year 2007, the number of project applications has sharply increased and this trend continued till then.[58] It suggests that the awareness on R&D increased and the wide acceptance of R&D funding schemes by the automotive industry reached a critical threshold. We come to the conclusion that the R&D project culture throughout the Turkish Automotive Industry has been widening since 2007. At this point, the critical questions arehow diverse these projects are in terms of technological fields and what is the project quality in terms of R&D and technology?

[58] Please remember that, in the preceding sections it was mentioned that the number in the last year, 2011, belongs only to applied projects number in Advanced Technology Projects; and the widely accepted R&D funding scheme by TTGV under the name of Technology Development Projects was terminated.

Table 9 Project numbers by sub-indicators, 1991-2011[59]

Indicators	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Total Project #	5	1		1	4	2	1	2	5	4	2	12	17	15	14	1
Innovation Level																
Firm	2			1	2				2	3	2		11	11	3	
National	3	1			2	2	1	2	3	1		11	6	2	9	1
International												1		2	2	
Technology field																
Traditional	3			1	4	1		2	2	2	2	9	13	12	8	
Contemp.	2	1					1		3	2		3	4	3	6	1
Both						1										
Market Orientation																
Domestic	2	1						1	1	2	1	1	3	2	3	
Abroad	1				1	2		1	1		1	1	3	1	1	
Both	2			1	2		1		3	2		10	11	12	9	1
NA					1										1	
Design intensivity and OEM presence																
Non-existent	1											1	1			
Specs by OEM	2					1				1	2	1	7	7	5	
Design Exist.	2	1		1	4	1	1	2	5	3		10	9	8	9	1
Innovation Type																
Process	1											2	6	2	2	
Product	4	1		1	4	2	1	2	3	3	1	6	7	9	12	1
Both									2	1	1	4	4	4		
Customers of Project output																
OEMs and JVs	3	1		1	1	1	1	2	2	2	2	7	11	8	7	1
Other	2				3	1			3	2		5	6	7	7	
Compensation Periods																
≤ 1 year	3	1		1	2	2	1	2	4	2	2	5	9	3	5	
1-3 years	1				1				1			5	4	7	2	1
>3 years												1	1	1	2	
NA	1				1					1		1	3	4	5	

[59] Among the years 1991 and 1995, there was no projects under the automotive industry.

Table 10 Technological fields and diversification of R&D projects, 1991-2011[60]

Period	Number of technological fields utilized through the R&D process	Number of sub-technological fields utilized through the R&D process	Number of projects in the period	Diversification rating
1991-2002	6	15	14	1,07
2003-2007	5	15	25	0,60
2008-2011	7	38	47	0,81

For diversification, we examine the sub-technological fields of each project in the sample regarding the technological classification in Appendix A. In Table 10 we present the results of this measurement for the periods provided in Section 4.5.1. It simply shows us the projects have not diversified throughout the subsequent periods regarding the diversification rating. The first period between 1991 and 2002 has the most diversified sub-technological fields while the subsequent period between 2003 and 2007 has the lowest. The diversification rating has an upward tendency in the last period, referring the fact that with the considerable increase in the number of project applications the diversification seems to increase. In general, it is hard to argue that technological diversification has increased through time but at least we can say that the project applications in the last years are more diverse in terms of technological fields compared to the previous periods. In terms of technological fields, the result is not very different.The maximum numbers of main technological areas of investigation through the R&D process in the projects are 6, 5 and 7, respectively, which does not give a clear trend. There is no evidence that provides any considerable increase or decrease for diversification among different time periods.

[60]The determination of technological and sub-technological fields have been performed according to the classification of vehicle parts provided in Appendix A by examining each project proposal in terms of their project subjects. The performed R&D operation in each technological and sub-technological field has been counted as 1 and the total fields in which R&D was performed through the projects has been calculated. This is why the value of 15 has been obtained for 14 projects in the first period. It means one of the projects out of 14 was about two different sub-technological fields for its performed R&D.

For testing the project quality, we utilize the above mentioned indicators and their sub-indicators in different periods. Utilizing the formulas in the preceding section we present the results in Table 11. Here, the central question is what does the numbers in Table 11 mean? Now, we turnback to our indicators and explain the results in Table 11 in terms of what these indicators tell in terms of technological sophistication of the aumotive industry in the last two decades.[61]

Findings for the Innovation Level: There seems a slight increase in national and international level of innovations in the second period with the percentage shares of 68% and 4%, respectively; however, this trend did not sustain and the shares of these kinds of innovations were decreased between 2008 and 2011. This might be due to theglobal crises of 2008,forcing the firms to be more productive rather than introducing new innovations. Here, the data does not show evidence oftransformation towards national or international level of innovations in the past two decades.

Findings for Technological Field: We do not see a rise in the shares of contemporary innovations in our sample; rather, it is steadily decreasing as we also add up the "both" row of the first period with contemporary technologies. The decrease is slight from 35,6% to 29,8%; though we consider there is no trend towards technological sophistication of the R&D projects.

Findings for Market Orientation: The striking finding is that firms were committed to have R&D projects aiming at designing innovations towards having opportunity to be sold out in both domestic and abroad markets. The share of these projects is dramatically increasing from 42,8 to 70,2 per cent. This result maybe referred as the variation of the market objectives while building up the projects, triggered by the augmented competitive pressures in the industry. We note a tendency towards technological sophistication of projects on the basis of varied markets.

[61]Note that while evaluating numbers, we have counted up the increases and decreases above 10 per cent in percentage shares as considerable increase or decrease that suggests an upward or downward tendency reflecting a type of transformation in the project sample.

Table 11 Indicator and sub-indicator values by project period

Time period		**1991-2002**	**2003-2007**	**2008-2011**
Indicator	**Sub-indicator**	14	25	47
Innovation Level	Firm Level	5	7	18
	Pct. share	35,7	28,0	38,2
	National	9	17	25
	Pct. share	64,3	68,0	53,3
	International	0	1	4
	Pct. share	0	4,0	8,5
Technological field	Traditional	9	17	33
	Pct. share	64,2	68,0	70,2
	Contemporary	4	8	14
	Pct. share	28,5	32,0	29,8
	Both	1	0	0
	Pct. share	7,1	0	0
Market orientation	Domestic	3	6	8
	Pct. share	21,4	24,0	17,0
	Abroad	4	4	5
	Pct. share	28,5	16,0	10,6
	Both	6	15	33
	Pct. share	42,8	60,0	70,2
	NA	1	0	1
Design intensivity and OEM presence	Design non-existent	1	1	1
	Pct. share	7,1	4,0	8,5
	Specs from OEM	3	4	19
	Pct. share	21,4	16,0	40,4
	Design existent	10	20	27
	Pct. share	71,4	80,0	57,4
Innovation type	Process	1	2	10
	Pct. share	7,1	8,0	21,3
	Product	13	15	29
	Pct. share	92,9	60,0	61,7
	Both	0	8	8
	Pct. share	0	32,0	17,0
Customers of project outputs	OEMs and JVs	8	15	27
	Pct. share	57,1	60,0	57,4
	Others	6	10	20
	Pct. share	42,9	40,0	42,6
Compensation periods	≤ 1 year	10	16	22
	Pct. share	71,4	64,0	46,8
	bw. 1-3 years	2	6	14
	Pct. share	14,2	24,0	29,7
	> 3 years	0	1	4
	Pct. share	0	4,0	8,5
	NA	2	2	7
R&D complexity	Average personnel/month per project (c_1)	0,95	2,02	1,46
	Average Budget per project (c_2)	524.972	657.260	475.406

Findings for Design Intensivity and OEM Presence: The findings suggest that the projects not involving design and design confirmation process is well below 10 per cent in each period of time. Here, the striking point isthe increased amount of OEM presence in design activities of the projects. This number is 21,4% at the very first period and thenrises up to 40% in the final period. This means that there is a strong OEM presence in the Turkish Automotive Projects through their role in providing specs and know-how transfer, showing up the dependent structure of the industry on JVs and OEMs. This fact may symbolize steadily decreasing technological sophistication in Turkish R&D efforts.

Findings for Innovation Type: As shown in the table, the presence of product innovations seems rather strong; nevertheless, what is worth the attention is the steady increase in the process innovations. Particularly, in the second and third periods, the share of process innovations 8,0% and 21,3%; supporting the belief that process innovations are of utmost importance in the time of crisis because of decreasing revenues (and perhaps a reaction towards maintaining competitive position). If the projects containing both kind of innovations is added up, this numbers rises to 40,0% and 38,3%, respectively. Here, we point out the motivationof productivity under the designation of R&D projects for the selected time periods. We do not see any evidence of inclination towards more technologically sophisticated projects under the constraints of our assumptions.

Findings for Customers of Project Output: This indicator gives the most stable numbers through different time periods and sub-indicators. The numbers with 57,1, 60,0 and 57,4 per cent for the OEMs and JVs as the customers explicitly shows that the main customers of Turkish R&D projects are JVs and OEMs. This finding is meanwhile parallel with the findings claimed by the indicator, Design Intensivity and OEM Presence. This finding also holds a strong support for the dependence of Turkish R&D on know-how and technology transfer from the OEMs and JVs. The dependent structure signals a more stable technological sophistication level over theyears however, this might also mean increasedcapability of the Turkish Automative Industry even though the dependence upon global value chain is confirmed.

Findings for the Compensation Periods: This is one of the interesting indicators showing that the compensation periods through time for a given projects is increasing. The projects being compensated under 1 year is 71,6 per cent at the first period, but it steadily decreases down to 46,8 per cent, trading off with the compensation periods over 1 year. This gives no support for technological sophistication of R&D.

Findings for the R&D Complexity: The numbers of this indicator – if the assumptions are appropriate, of course- portray R&D complexity, - in terms of project budgets, charged personnel and realized project durations – increasedin the first period, particularly for personnel/month numbers, but then decreased in the last period. On the basis of these numbers, we might reject technological sophistication without neglecting the forecasted constraints for the measurements. In brief, Table 12 sums up the findings above.

This section outlines the findings using the predetermined indicators which are thought of as important and representative in the context of R&D project evaluation. We have reached the conclusion that 7 out of 8 of our indicators point that there is no tendency for technological sophistication of R&D projects in the automotive industry under the given data constraints. Individually, these indicators may not mean much. However, as a whole, they show that there is no evidence that technological sophistication in the last two decades increased, rejecting the main hypothesis.[62]

[62]To have a different outlook and validate our findings, we also work with an alternative timeframe by dividing it into two periods rather than three. These are the periods separating the years as 1991-2003 and 2004-2011. We have calculated 6 out of 8 indicators with their sub-indicators as provided by Appendix B. The results are nearly the same or they are inconclusive, offering similar findings for our hypothesis and not reflecting a tendency towards technological sophistication.

Table 12 A brief summarieson the indicators, their explanations, findings and test of the hypothesis

Indicator	Explanation	Finding	Technological Sophistication
Innovation Level	• Gives the level of innovation in the R&D project. • Innovations towards national and international level requested	There is no tendency towards national or international level of innovation	No
Technological Field	• Offers the area of R&D • Transformation for contemporary technologies requested	No transformation for contemporary technologies detected	No
Market orientation	• Gives the objective of innovation output towards export • Transformation for export orientation requested	An objective for varied markets and export detected	Yes
Design Intensivity and OEM presence	• Gives the presence of design and design confirmation processes; but also test the OEM presence in design activities • An inclination towards design without depending upon OEMs and JVs requested	Design and design confirmation processes are common in projects; however, OEM presence is increasing in these activities	No
Innovation type	• Gives the objective of innovation in the project • A tendency towards product innovations requested	Even though the product innovations are the major component of R&D motivation; process innovations is in increase	No
Customers of Project Outputs	• gives the customers of the project outputs • A tendency towards different customers and end products is requested rather than procuring OEMs or JVs what they are outsourcing	OEMs and JVs are still dominating the customer portfolio of the project owners. Findings are in line with the findings as in OEM presence in design activities	No
Compensation Periods	• Based on the assumption that more sophisticated products need less compensation time for project budget • Shorter compensation times requested	Rather than shortening, compensation time for R&D project budgets is getting longer	No
R&D complexity	• Based on the assumption that R&D complexity is getting increased with more allocated budget, recurred personnel • More R&D complexity requested	The numbers obtained from different sub-indicatorsshow a dramatic increase and then a considerable decrease in averaged sub-indicators	No

4.6. Conclusion and Discussion

In this chapter, our focus has been the dynamics of technological sophistication of R&D projects in the Turkish Automotive Industry. We use data from TTGV whose R&D support experience covers the longest period in Turkey.

Firstly, we begin by explaining the findings about the raw data. The data shows that the majority of R&D performers have Turkish origin with previous R&D experience before applying to TTGV. Firms have international certificates showing their capability to operate with global OEMs, JVs etc. but they are mostly dependent on the foreing affiliates. Mainly, project proposers have domestic capital formation and they were in majority auto-suppliers.

In our sample, projects have national level of innovation and product innovation has been the most common of all innovation types. The projects have been made in more traditional parts of an automobile related to body, body equipments and power-transmission parts as the contemporary technologies lagged much behind. OEMs and JVs are seen the major customers of the project outputs and market orientation of the projects are towards both domestic and foreign. Projects commonly have a compensation period of 1 year or 1 to 3 years meaning that the R&D activities are not meant for radical innovations. Further support to this claim is coming from the fact that most innovations triggering new markets are at the firm level. The national or international level of innovationsare not so common and international level of market penetration was highly dependent upon projects triggered by the OEMs and JVs. This is another evidence for dependence of the industry on foreign dynamics.

Upon the findings from the raw data and statistics, we measure the dynamics of different periods of R&D subsidization by separating our data in to three periods. We set up the indicators, defining clearly what we refer as technological sophistication and form the main hypothesis to be tested by using the data. We also classify the projects in terms of their technological fields to find out their diversification throughout the time.

For diversification of the projects, the results show that projects have not been diversified in terms of their technological and sub-technological fields by regarding the diversification rating we calculated. This finding also supports our hypothesis stating no technological sophistication in terms of technological fields of the R&D projects in the sample.

The findings show that the innovation level of the projects has not been transformed into national or international level of innovation. We have not detected an inclination towards technological sophistication in this manner. In contrast, we found that the shares of innovations at the firm level increased. It could be the case that the industry is still experiencing a learning process and perhaps the future projects will be more sophisticated in terms of the context.

The data shows that there is a slight increase in the shares of traditional technologies meaning that the R&D project proposals are mainly on traditional technologies rather than comtemporary technologies,referring no sign of technological sophistication.

It seems that the market orientation is the only positive indicator in term of technological sophistication. From our data and measurements, we observed a positive inclination towards more varied markets and increased export-orientation. We argue that one of the reasons for this is the competitive pressures upon firms emerged after the global recession of 2008.

For the indicator of Design Intensivity and OEM presence, the results need considerable attention. The most obvious point is that OEM presence by providing know-how, specs and technology transfer has increased over the years. The positive aspect of this for the industry is that it symbolizes a trend towards a better integration to the global value-chains and the industry has more absorptive capacity andknow-how. However, one major drawback is that the automotive industry has become increasingly dependent on the OEMs, JVs and foreign affiliates over the years. This one-sided integration may act as a major impediment against technological sophistication and leapfrogging.

For the innovation type, even though the aim of the projectsis mainly product innovations, this changed slightly over time. Recent projects are more inclined towards process innovations. We claim this might be a result of competitive pressures of harsh global competition. In this way, the R&D projects are aiming more at sustaining the current position in slight increases in competitiveness through process innovations.

For customers of project outputs, the remarkable finding is the increased amount of OEM and JV presence behind the motivation of doing R&D. The finding is consistent with the findings of increased OEM or JV presence behind know-how transfer. These two findings together is an evidence of the dependent structure which we already argue that it is major drawback against the future of the industry.

In contrast to the expectations, the forecasted compensation periods of firms are getting longer as the data suggests. This seems as a contradictory argument if we expect more creativity and novelty from the projects as time passes. This result is also confirming no technological sophistication as we defined.

Finally, the sub-indicators we designated for R&D complexity also shows a stable trend among three different periods. We consider that there may be different ways to measure R&D complexity but we tried our best given our data.

For subsequent chapters, what do these findings tell us? In our case studies involving a mixed approach – a comprehensive methodology to overcome the limitationsof the TTGV data, we strongly believe that we should first verify these findings and then, comment on what might be the reason that the technological sophistication of the projects has not increased over time. Below we give a brief explanation of the topics that makes the basic issues to be explored in Chapters 6 and 7:

1) The innovation level of current R&D: Performed R&D in firms -and in the industry, as well- should be investigated further in-depth with specific reference to innovativeness (i.e., compare Turkish projects with other state-of-the-art innovations to see their technological level). Innovations that are

new to the firm are of course important but they are rather productivity oriented.

2) Transition to more contemporary technological fields: The intensive usage of traditional technologies might be the main determinant behind the lower value-added in Turkish Industry. As our data provides, we have no argument to be used to claim that there is a common development process of contemporary technologies in the industry. Then, it is investigate further whether there is an increasing utilization of contemporary technologies such as body materials, electrical equipments, digital system designs etc.
3) More sophisticated markets and products: More sophisticated markets and products, in innovative terms, demand a certain technological level. They also offer more value-added to the performer. The only positive finding supported by our data regarding varied foreign markets should be further tested in subsequent case studies.
4) OEM presence both as know-how provider and main customer: Our data shows that OEM and JV presence has increased both in design processes and procurement. Selling out the products to OEMs and JVs is a good sign (the industry is better connected to the global value-chains) nevertheless, technological sophisticationimpliesmuch more independent players producing end products on their own efforts. The dependence on OEM and JVs should be further investigated by asking for their pros and cons both to the firms and the experts.
5) Productivity increase vs. product innovation: It is undeniable that productivity increase is important in an industry such as automotive industry, composing of mass and batch productions. However, we have defined technological sophistication as a state with more technology-intensive products attained by creativite and design intensive R&D, inferring more complex R&D. So, the motive towards product vs. process innovation will be further investigated to comprehend this.

In conclusion, by jointly considering all the indicators we discussed in this chapter weargue that there is no upward tendency of technological sophistication in the R&D projects in our sample of automotive industry firms. Turkish Automotive Industry is strongly dependent upon JVs and OEMs abroad. The role of R&D and innovation in the Turkish export success is rather exaggerated. There are other motives that drive this success such as productivity increase behind the R&D efforts and that Turkey become a major hub of manufacturing rather than a hub of technology. Turkey has not worked upon contemporary technologies of the industry except some projects and for instance, a vital component of success such as the adoption of electric and electronic technologies of automobile equipments has been widely missed. In accordance with the findings, we have not seen a positive transition of the industry in terms of technological sophistication. But, it might be considered that Turkish Automotive Industry has accomplished a significant learning period that might affect the future success.

Although the method that is utilized in the chapter to evaluate the projects is rather novel, difficult to apply and bounded by some (strong) impediments, we still think that it is a useful qualitative way to assess the quality of R&D and innovation rather than the quantity.Complementary to the impact analysis in which difference in difference models are commonly used, we strongly believe that this method based on deeper understanding of project quality rather than quantity is capable of understanding the dynamics of technological sophisticationin an R&D in a determined timeframe. Finally, we also argue that this method is convenient for analysing the transition and development of R&D in a specific industry.

CHAPTER 5

Firm cases in Turkish Automotive Industry

5.1. Introduction

Given the several indicators and hypothesis put forward in Chapter 4, we now continue our investigation at the firm level. Chapter 4 proposes that there is some kind of dependence of Turkish automotive manufacturers on global OEMs on strategic issues such as R&D, know-how and technology transfer. R&D in Turkey is usually sustained with the provision of specs from the OEMs. General outlook of the projects in Chapter 4 shows that the motivation behind the projects is mostly global OEM-oriented, which restrictssophistication of the R&D contextto more traditional technologies with the provision of less value-added. However, due to limited time coverage and number of firms (althoughwe used all available TTGV data on the automotive industry), TTGV data has its limits. At first, we need to further develop our study to understand the current situation at the micro level. For this reason, we establish a firm-based study to investigate the micro-based evidences regarding technological sophisticationatthe firm level. For this aim, we carefuly selected reprensentative firms from the 86 projects we analysed in Chapter 4. The selected firms have at least one R&D project applied to the TTGV support programme that is briefly explained in Chapter 4. We conducted semi-structured interviews to investigate the details of the R&D context and output, innovation and finally, how sophisticatedthe R&D is and the driving factors behind technology development. This firm-based study might be considered as the in-depth analysis of what we have

investigated in the preceding chapter. Thus, one can also view this chapter as a stand-alone robustness exercise. It is supposed to overcome the limitations of Chapter 4 as it provides micro-evidence about firms' R&D decisions, R&D performances, interrelationships with OEMs, their strategy about innovation, R&D outputs and their commercialization etc.

During the interviews we expected to attain the following benefits to strengthen our findings in Chapter 4.

- To attain more insights about domestic firms' spec, know-how provision and technology transfer by OEMs by investigating how and why the domestic firms are dependent on foreing OEMs.
- To further understand the sectoral interrelationships in which we are trying to analyze,
- The level of technological sophistication in performed R&D projects of the selected firms,
- Firms' opinions about R&D subsidies and policies in Turkey,

In accordance, we already offered five issues in Chapter 4 to be further examined which were i) the innovation level of current R&D, ii) whether there is a transition to more contemporary technological fields, iii) whether post-1990 era witnessed more sophisticated markets and products, iv) OEM presence both as know-how provider and main customer, v) the main motivation behind R&D and innovation (productivity increase vs. product innovation). In this chapter four topics have been analysed accordingly:

1) R&D context: The context of performed R&D in a given firm by controlling the motivation behind the projects, OEM presence on decision-making, its technological field in terms of our technological classification, the innovation level, the sophistication and evolution of the performed projects.
2) R&D output: The output of performed R&D in a given firm by controlling the presence of OEMs or outsourcers on the decision of commercialization,

firms' expectations from their performed R&D, the returns of R&D on firms' performance, the market orientation of R&D output

3) Firm strategy on innovation: The strategy of a given firm about R&D involving more specialized fields of expertise, more sophisticated projects and products etc.
4) Firm's opinions about R&D subsidization and technology policies in Turkey: The general opinion and evaluation of a given firm about Turkish R&D subsidization and technology policies in Turkey.

These subjects are all to be discussed in this chapter on the basis of technological sophistication. Subsequent sectiondiscusses the methodology of the firm interviews; and then, we discuss the findings from firms in accordance with the stated topics above. In the conclusion part, we outline the main findings from the interviews about technological sophistication. We assert that findings offered in this chapter give invaluable insights about technological sophistication at the firm-level corroborating our findings in Chapter 4.

5.2. Context and detailed methodology of firm interviews

This section aims at explaining how firm interviews were held and the goal of the interviews that are thought to be the baseline of microeconomic views onthe Turkish Automotive Industry. In order to attain this aim, we briefly explain the context of the interviews as given in the subsequent paragraphs.

Each interview started with a short meeting up section. We asked the interviewee about his/her position in the firm and the brief explanation of his/her firm. We explained why we were conducting the interviews and mentioned briefly about our hypotheses in the dissertation. This meeting up section was important for both parties -interviewer and interviewee-to understand each other. We also guaranteed the possible privacy concerns of interviewees by promising to share the information without giving any person and firm titles and names. In this way, the interviewers were more confidentto give information and felt free to discuss his/her thoughts about our questions.

The semi-structured questionnaire was the core part of the interviews. We asked the questions in four sub-headings involving R&D context, R&D output, firms' strategy in terms of innovation and firms general opinions about R&D subsidization policies and Turkish Innovation System.[63] The main objective of all these questions was to find out whether the firms actually perform R&D on more technologically sophisticated areas.It is important to note that during interviews, interviewees were not directed in terms of technological sophistication (i.e., the preliminary findings in chapter 4 regarding technological sophisticationover the years were not mentioned); and the assertions in the subsequent sections are to be suggested by accumulated evaluation of interviewer regarding the firms' answers. The detailed context of interview questions can be found in Appendix C.

As explained in detail in Section 3.5.2, the questions were posed to R&D managers or high-status members of firms with face-to-face interviews which were lasted between half an hour and one and half an hour. The interviewees were selected from R&D managers or from vice managers who have completely supreme excellence both in their jobs and in the automotive industry. Furthermore, interviewees were let to feel free about what they would like to offer due to possible privacy reasons convenient to firm strategy. The interviewees were not obliged to answer any question he/she would not like to answer at all or would hesitate to answer. The main motive behind interviews was to assess whether the firm has managed to perform more technologically sophisticated projects. If not, the possible reasons are also examined. During the interviews, interviewer also took advantage of what expert interviews and TTGV data propose for further research.[64] For example, we asked questions regarding concept design -which is an essential part of advanced R&D projects and, in general, triggered by determining market needs-to understand if the firms were dependent on a foreign affiliate or an outsourcer in this sense, or they take the market signals before performing R&D. This and other similar questions that are used in the semi-structured interviews were mainly formed to obtain further details on some of the topics that were unclear in Chapter 4. So the

[63] The contexts of these sub-headings are given above paragraphs.

[64] Expert interviews were sustained simultaneously.

basic aim was to fill the gaps in Chapter 4 and increase our understading of what really happens at the shopfloor.

15 firms were selected from the TTGV database and 13 of them were intervieweed.The firm list is given in Table 13.

The sample of firms involves 5 SMEs, 6 big enterprises, a joint venture and a foreign affiliated global brand. We selected these firms to have a group as comparable as possible to the population of firms that received funding from TTGV. It is supposed that SMEs reflect how small Turkish-owned procurers operate in an industry with their ties connected to OEMs while big enterprises explicate how small firms grow in the industry. JVs and foreign-affiliated Turkish branches represent how Turkish firms are connected to the global automotive industry. In the current industrial organization of the Turkish Automotive Industry, thousands of SMEs and hundreds of big firms are operating for OEMs and global brands, some of which are located in Turkey with their own branch. We consider that these branches establish a bridge between Turkish firms and the global OEMs by providing knowledge transfer and by letting Turkish manufacturers to operate for global markets.

When we were selecting the firms, we also paid attention to the core competences of the mentioned firms. Within the group, there are suppliers, design and engineering firms, a raw material manufacturer for the auto industry, firms specialized in more niche areas like accumulator production or heavy component production. Both domestic and foreign affiliated firms are involved in the sample. The geographical locations of the firms are distributed to represent the Turkish Automotive Industry. There are three firms from Bursa, Kocaeli and İzmir respectively, two from Manisa and one from Eskişehir and Ankara so that, for the selection of our sample, we have aimed at taking each city having considerable presence in the national industry.

Table 13 List of Firm Interviews

Firm	Description of the firm	Category	City	Title of Interviewee
SME1	A domestic design and engineering firm for auto design. It is also affiliated with the domestically-owned midibus and military vehicle manufacturer.	SME	Kocaeli	R&D Manager
SME2	A domestically-owned clutch procurer for automobiles and buses.	SME	İzmir	R&D Manager
SME3	A domestically-owned brake components manufacturer for the global brands by using foreign licence.	SME	İzmir	R&D Manager
SME4	A domestically-owned front/rear axle procurer for global OEMs.	SME	Bursa	R&D Manager
SME5	A domestically-owned procurer manufacturing plastic assembly parts for automobiles.	SME	Bursa	Vise Manager
BIG1	A reputative company specialized in installing automation and robotics mass production lines on JVs.	Big Enterprise	Kocaeli	Vise Manager
BIG2	A highly reputative spring supplier for heavy vehicle OEMs. It is domestically-owned.	Big Enterprise	Manisa	R&D Manager
BIG3	A domestically-ownedsupplier for global heavy vehicle manufacturers. It operates in a niche market.	Big Enterprise	İzmir	R&D Manager
BIG4	A renowned accumulator and battery producer and operating worldwide. (Former shareholder was foreign)	Big Enterprise	Manisa	R&D Manager
BIG5	A domestically-owned tructor, customised automobile, vagon parts and heavy parts manufacturer	Big Enterprise	Eskişehir	R&D Manager
BIG6	A domestically-owned and globally-owned cord fabric manufacturer for international tire brands. It is operating under one of the biggest Turkish business group.	Big enterprise	Kocaeli	R&D Manager
FA1	A foreign-affiliate of a renowned bus manufacturer.	Foreign Affiliate	Ankara	R&D Manager
JV1	A Joint Venture which is a sub-branch of a globally renowned automobile manufacturer	Joint Venture	Bursa	R&D Manager

(Abbreviations: SME: Small-Medium Enterprise BIG: Big Enterprise FA: Foreing Affiliate JV: Joint Venture)

We interviewed with each firm once in the list. As mentioned, the questionnaire was implemented in a semi-structured format with face-to-face interviews. The meeting was held between half and one and half hour according to the business schedule of the interviewee. In each case, the questions were fulfilled with guidance of the interviewer.In the next section, we propose our findings from these interviews.

5.3. Findings from the interviews

We begin by considering R&D context of the projects performed by the firms focusing on technological sophistication. On behalf of the R&D context, we looked for performed R&D with less dependence upon global OEMs in more contemporary automotive technologies. Then, we investigated in detail the outputs of the R&D activities that can manage to attain what definition of technological sophistication requires: more participation to decision-making on commercialization and the introduction of R&D output on more sophisticated markets with niche features. We then evaluate innovation strategy of the firm by detecting the OEM presence on the design capability of the firm in its performed R&D projects and by controlling their opportunity to generate more specialized businesses on state-of-the art technologies. The favourable answers to these questionswould mean that firms are sophisticating their R&D efforts with the alleviation of their dependence on global counterparts and by introducing more sophisticated R&D outputs to the market. Then, we outline the recommendations of firms about R&D subsidization and science, technology and innovation policies in Turkey. This chapter is concluded by outlining our further assertions on the level of technological sophistication in the Turkish Automotive Industry.

We start by discussing the R&D context of the performed projects in selected firms in terms of technological sophistication. But before starting, we summarize our findings in Table 14,which we think would be useful for the reader. The discussion of the table with a special focus on R&D context, R&D output, innovation and policy can be found in the following sub-sections.

Table 14 Summary results of the firm interviews: R&D context, R&D output and innovation

Firm	Core Specialization	Core Technology	How R&D projects are initiated?	Product orProcess innovation	Specs from Outsourcer	Commercialization Decision	Projects in niche or sophisticated products	Innovation Level	Diversified Core Competency	Technological Sophistication
SME1	Design and engineering firm of a domestic OEM	Contemporary	By the affiliated OEM or market signals	Product	Yes	Dependent on OEM	Yes	National	Yes	Yes
SME2	Supplier	Traditional	By the outsourcer	Both	Yes	Dependent on OEM	No	Firm	No	No
SME3	Supplier	Traditional	By the outsourcer	Both	Yes	Dependent on OEM	Yes	Firm	Failed	No
SME4	Supplier	Traditional	By the outsourcer	Both	Yes	Dependent on OEM	Yes	Firm	No	Yes (due to its phase of being a co-designer)
SME5	Supplier	Traditional	By the outsourcer	Product	Yes	Dependent on OEM	No	Firm	No	No
Procurer BIG1	Engineering firm and assembly line procurer for global OEMs	Contemporary	By the outsourcer or market signals	Both	Yes (for niche projects No)	Dependent on OEM	Yes	National	Yes	Yes
BIG2	Supplier	Traditional	By the outsourcer	Both	Yes	Dependent on OEM	Yes	Firm	No	No
BIG3	Supplier	Traditional	By the outsourcer	Both	Yes	Dependent on OEM	No	National	Failed	No
BIG4	End product manufacturer	Contemporary	By market signals	Product	Yes (for niche projects – No)	Independent	Yes	National/ international	Yes	Yes
BIG5	Supplier/end product manufacturer	Traditional/ Contemporary	By the outsourcer or market signals	Both	Yes (for niche projects – No)	Dependent (for niche projects – independent)	Yes	National	Yes	Yes
BIG6	Supplier	Traditional/ contemporary	By the outsourcer or market signals	Both	Yes	Semi-Dependent	Yes	National	Yes	Yes
FA1	Supplierof an affiliated MNE	Traditional/ contemporary	By the affiliated MNE	Both	Yes	Dependent on headquarter	NA	National	No	No
JV1	Supplierof an affiliated MNE	Traditional/ contemporary	By the affiliated MNE or firm's own initiative	Both	Yes	Dependent on headquarter	NA	National	Yes	Yes

5.3.1. R&D context

In this study, because R&D is at the focus, it is reasonable to shed some light on the motivations behind conducting R&D. The main questions we askare: Why do firms perform R&D? How is the R&D process initiated?[65] With these questions in mind, we aim to see whether the firm is performing R&D ignited by market signals to survive or grow in the market or only by taking signals from its outsourcer. Taking market signals refers there is a more suitable environment for concept design[66] unless the firm is assigned for this process by its outsourcer. Furthermore, firm has more initiative to design concepts by taking signals outside rather than obtaining them as ready and given by the outsourcer. In contrast, taking specs from outsourcer makes the performing firm more dependent by neglecting the concept design phase and only focusing on process innovation to reduce costs to have better profit margins. The expert interviews in the following chapter also suggested a similar reasoning.

The dichotomy between performing product or process innovation has been a long-standing debate in the literature started by Utterback and Abernathy (1975) is another concern for us.[67] Product innovations are more open to have concept designs

[65] Besides our concern, the motives behind performing R&D at the firm level is a debate in the literature which focuses on the differences of innovative firms that are R&D or non-R&D performers. Castillejo et al. (2001) argued that firms persistently performing R&D benefits from dynamic increasing returns to R&D activities. Furthermore, Gonzalez and Pazo (2004) claimed that the main determinant for R&D decision for a given firm is about R&D expenditure that reaches a critical threshold. For other discussions about this issuesee also Huang et al. (2010), Peters et al. (2013), Arundel et al. (2008).

[66] Concept design is the vital element of performing R&D. Concept signals are taken from the market and by utilizing several methods firms adopt themselves for brand new innovations that markets have not met yet. Rather than using given specs by the outsourcer, developing new concepts by using advanced tools and methods is capable of developing firm capabilities during performing R&D. Complete R&D cycle is fulfilled, only if, by utilizing the methods of concept design (Şenyapılı, (2010).

[67] The drivers of firm decision to perform product or process innovation has a prevailing position in the literature. Utterback and Abernathy (1982) argue that this decision is taken by a given firm with the provision of two determinants involving the stage of development of production process and chosen basis of competition. In the early 90s, the idea of Porter (1990), stating that "innovation is good for competition", was supported by emprical evidences of Bailey and Gersbach (1995), Blundell, Griffith and Van Reenen (1995) and Nickell (1996). However, later arguments proposed by several studies such as Bannono and Howarth (1998), Boone (2000), Lin and Saggi (2000) and

by requiring more creativity and innovation while process innovations referto an objective towards productivity gains. Unsuspiciously both are fundamental for the industry.However, in terms of technological sophistication, we have addressed for novel attempts particularly on product innovation as an end product because, as Rosenkranz (2003; pp. 183) claimed, "firms' investment is also driven to product innovation, if the consumers' willingness to pay is high". Technologies, on which selected firms are performing R&D, are also important for our firm-based evaluation, referring niche areas to be searched for. The collaborative nature of the R&D offers us to investigate the firms' inclination for collaborative research which is an indispensible component of global R&D activities (Miotti and Sachwald 2003; Belderbos, Carree and Lokshin 2004; Nieto and Santamaria 2007; Czarnitzki, Ebersberger and Fier 2007). Finally, we ask the firms to evaluate their last five R&D projects to at least have an idea on the evolution of how sophisticated technology they use (or develop).

The first discussion to open up is the motivation behind R&D at thefirm-level. From our interviews we have the view that this depends on the core technology area of the firm, approving the arguments of Peters et al. (2013), but in general, we argue there are strong effects of OEMs on the decision-making of the Turkish firms. This argument is also in parallel with the propositions of Ölmezoğulları(2011) and Pamukçu and Sönmez (2011). For example, SMEs in the sample have strongly emphasized that they are forming their R&D projects based on the orders of their global outsourcers. SME2, SME3, SME4 and SME5 are all dependent on global outsources with the exception of SME1 that is a stand-alone design and engineering firm, connected to a Turkish midi-bus brand. This refers a more independent vertical relationship for SME1, reflecting presence on R&D decision-making. One should pay attention to the fact that the only case when a firm has some decision power on R&D is the case of domestic firm-domestic end-product manufacturer. The other point to examine is the case of SME4 asserting that they are reaching a position of a co-designer. SME4 stated that:

Rosenkranz (2003) challenged this view by claiming there are other determinants such as firm size, competition intensity, product variety on the decision of firms for performing R&D to innovate.

> *In some parts such as door, hinge etc., attaining a co-designer position is much easier. But, in parts being strategically important to OEMs, it is much difficult to take a position like that. We also got involved in NY Taxi Project, Karsan V1 and we can easily claim that domestically-owned end products provide much more design capabilities for the firms similar to us. If JVs like TOFAŞ and Renault were of solely domestic origins, it would be much easier to disseminate their knowledge to domestic procurers.*

On behalf of the big enterprises, we have observed some differences. Because firms, BIG1, BIG2, BIG3, BIG4, BIG5 and BIG6, have more capacity and financial resources to innovate, they are freer in their decision-making. For example, BIG1which is a design and engineering oriented firm, has developed R&D projects such as electrical car components and autonomous flying service robot for data receiving. In contrast, on their core businesses to build up custom-made automation lines to Turkish JVs and global OEMs, they are highly dependent to foreing partners. But, as their revenues accumulate from their core businesses, they are trying to open up a space for new core capabilities in future technologies. Our observation is that such a strategy so far seems successful. Moreover, BIG2 and BIG3 seem more similar to the position of SMEs. Their core business is in more traditional fields of automotive industry (producing parts for the heavy truck manufacturers) and they perform R&D whenever they need to solve a problem rather than with a strategic decision to grow or to penetrate to related technology fields. BIG4, BIG5 and BIG6 have different core competences in comparison to the general outlook of the Turkish Industry. For instance, BIG4 operates in a sector, which does not intersect the core competences of the global automotive manufacturers. So, they become more independent on their R&D decision-makingandby foreseeing future trends, they have capability to innovate in their core technologies, which is not so much guided and driven by global OEMs. They also stated that after the departure of their foreign partner; they have become freer to take advantage of the performed R&D which means that foreign affiliates, partners, outsourcers have influence on commercializationas well as R&D decisions.BIG5 hasa very different range of product portfolio, ranging from heavy parts for railways to concept car design. With their capabilities and having domestic market signals,

they have formed a project involving design, prototyping and production of a small 4X4 off-road car. The revenue attained so far is too small but the firm is optimistic about the future of its concept. They are further developing the concept by making it an electrical vehicle. BIG6 procures raw material for tire manufacturers and stated that they are performing R&D towards global trends of tire manufacturers. They have pointed out that R&D on their core competence is likely to give them more space on the sector.

FA1 and JV1 can be grouped in a different category of firms since they have strong relationships with their headquarters. FA1 stated the motivation behind their R&D is sourced by the firm's main R&D department in their headquarters. JV1, having also a domestic origin as a JV, puts its motivation more strongly to take some parts of the R&D of the big projects to the national plant. JV1 had managed to survive by taking some car design projects from abroad partner[68] and actually, is more capable of considering the advantage of developing capabilities and taking R&D from abroad. Particularly, on JV1, this motivation seems more explicitly. This finding also brings into the mind the arguments of Ekmekçi (2009), stating that the advancing capabilities of foreign affiliates help locate themselves in the upper tiers of the global MNEs.

Secondly, our findings have asserted that the tendency of firms towards product or process innovation depends on the combination of different determinants involving firm core businesses and technologies, their capacity to innovate and their types of connection to the outsourcer or OEM. On behalf of core businesses and technology, our findings supports the view of Peters et al. (2013), asserting that firms operating in contemporary and emerging technologies are more open to advance their R&D performances. Except BIG1 and SME1, firms in the sample produce intermediary or end products, which are the main source of their revenues. So, they are reasonably keen on performing product innovations as expectedly. SME2, SME3, SME4, BIG2 and BIG3 conduct innovation on products assigned by OEMs. It is also important for them to innovate on process innovations as well, because they are suppliers in a

[68] This is to be discussed in the next chapter.

fierce competition of global industry, reminding the arguments of Porter (1990). They are supposed to produce cheaper and cut costs through time in procurement contracts. So, process innovation is a vital strategy to secure their positions for sustainability. BIG4, BIG5 and BIG6 hold both type of innovation together; process innovations to sustain efficiency for their bigger plants and product innovations for penetrating into diversified markets. Actually, regarding product innovation, BIG4 develops new type of accumulator for compensating newly emerged needs in the automotive industry and BIG5 offers a new concept car in a niche segment. Moreover, BIG6 uses process innovation as a way to decrease raw material costs for the industry and product innovation to increase its presence in the global markets.

FA1 and JV1 are operating as a branch of a global end product producer. This offers them a wide range of innovation possibilities. They also perform process innovations to decrease costs in order to locate themselves in the upper status within the ranking of their headquarters.

BIG1 and SME1 have a different perspective with respect to others. BIG1 is actually developing custom-made production/assembly lines.As their main source of revenue generation, they develop different solutions in the form of R&D projects for their every single customer. SME1 is assigned by a national midi-bus producer to develop solutions to its needs; hence, they make both product and process R&D in accordance with the context of an assigned project. One final note is that BIG1 has taken the initiative and is looking for an end product, having potential to trigger sustainable gross revenue. With this aim, it has developed two product innovations that have not been commercialised yet.

In terms of our technology classification involving traditional and contemporary fields of technology; SME2, SME3, SME4, SME5, BIG2 and BIG3, are present in more traditional fields of technology while the rest can be counted as operating in contemporary technologies. For firms in traditional technologies, 4 of them are SMEs and 2 of them are big enterprises. 7 out of 13 can be referred as in contemporary technologies in terms of our given definition. Here, we should state that BIG5, FA1 and JV1 can be counted as performing in contemporary technologies

because we involve the efforts towards manufacturing a whole vehicle in the context of this field. The other three firms, BIG1, BIG6 and SME1 are related to contemporary technologies for several reasons. In the case of BIG1, besides their core competence; as mentioned before, they perform R&D with the motivation of having their own end product. These contemporary fields are electrical vehicle technologies and autonomous air service robotics. SME1 is also assigned for state-of-the-art automotive technologies by its domestic affiliate in Turkey on the subjects of fuel cell and direct spare technologies. Finally, BIG6 is on a very different field of technology about vehicle tires, continuously developing different types of chord technologies for the tire manufacturers.

Niche products and technologies are also as important as the core businesses. Duringthe interviews, several firms have stated their niche areas of investigation. Besides BIG1 and SME1 with their niche area of competence, some other firms in the list have emphasized their commitment to niche technologies. For example, BIG2, as a spring supplier, have been studying about composite material technologies for about two years, noting the importance of composite technologies on the alleviation of heavy vehicle weights. In addition, BIG1 has attempted to have an expertise on electrical vehicle components while BIG4 is working on micro-hybrid and gel accumulators. BIG2 also stated that they are working on a special project with a research centre abroad, having potential of being a radical innovation on leaf spring. Lastly, FA1 and JV1 did not mention about being involved in a niche project. This is possibly due to their privacy policies, not sharing "strategic" kind of information with the interviewer.

Collaboration with other partners is a fundamental element of advanced and sophisticated R&D projects. Particularly, pre-competitive collaboration for R&D projects symbolizes the threshold a given firm has reached on their efforts. In our interview sample firms are more or less collaborating with other firms and universities as well. This finding approves the arguments of Güleş et al. (1997), mentioning Turkey has reached a "collaboration phase". It is also in parallel with the arguments of Kozan et al. (2006), Wasti et al. (2006), Wasti and Wasti (2008 and 2009), insisting on the persistent collaboration of firms based on trust. But an

important fact is that almost none of the firms mentioned about pre-competitive collaboration(even FA1 and JV1 which are the branches of global players), which suggests that trust relations exist in the vertical chain but are readily absent in the horizontal sense (i.e., two firms developing similar technologies collaborate).

For the development of their R&D projects towards more technologically sophisticated ends, firms were not assertive. In general, they hesitated to make such a strong claim. Among the given firms, SME2, SME3, SME5, BIG2 and BIG3; we are not able to assert an upward trend towards more sophisticated projects. In accordance, SME3 stated that:

> *We are producing brakes under a foreign licence and we are taking specs as ready from our abroad partner. We cannot claim that we have succeeded in developing more of our projects and has reached a certain level of sophistication. Our projects might resemble to each other; but each one is important for us to penetrate to the new markets.*

BIG3 also commented for their sophistication level on their projects as given below:

> *We are trying to pass into the phase of system supplier and this enforces us to adapt electrical parts of brakes to our components. Because our core business is mechanics, we do not consider going into electronics; even if we develop towards being a system supplier by adopting electronics parts to our production. In that case, we are to procure them from the partners having core businesses on electronics.*

As we see from the quotes above, some firms that cannot afford to produce more sophisticated products lock-in within their old technology areas because of their core specializations. They are not able to diversify their technological area of specialization due to their strong dependence on their old core technologies. As in this case, firms specialized in mechanics have difficulties to adopt themselves on electronic technologies as an additional core specialization. Particularly, the ongoing trend of increased presence of electronics on vehicles obligates to adopt mechanics with electronics under the name of a new contemporary field called mechatronics; however, we have observed that it is hard to be adopted particularly for procurers of traditional auto suppliers in the periphery countries.

For other firms, the picture is a little bit different. Though, BIG1 and SME1 is innovative due to their core businesses, they have not claimed they have sophisticated their projects. However, to our knowledge and based on the information they have provided, we consider that they have reached a certain level of improvement on technological sophistication. We also consider the same for the niche producers like BIG4, BIG5 and BIG6. Moreover, FA1 and JV1 can be grouped in a different perspective. FA1 claimed there is a development on R&D activities, but neglecting sophistication in this sense. JV1 did not provide a fulfilled answer about the details of their R&D projects. Nevertheless, as we take into account the background and current development of the JV, we are confident that they have reached a critical threshold.

We make two assertions regarding technological sophistication to conclude this section:

***Assertion 1*: R&D capabilities tend to develop in a sophisticated mannerfor SMEs if the outsourcer of a given firm is a domestically-owned end product manufacturer that disseminate knowledge and give more power to the procurer firm on strategic R&D decision-making processes in a well-defined vertical relationship.**

***Assertion 2*: Especially for the SMEs in the sample, dependence on a traditional field of technology on their core-competences might impede efforts towards developing more sophisticated R&D projects due to lock-in to their traditional core technologies.**

5.3.2. R&D output

In the context of R&D output, we have concentrated on the successful innovative projects of performers and their outputs by questioning their export tendencies and commercialization. According to the definition of technological sophistication prescribed in Chapter 4, it is significant for the performer to have independent commercialization decisions convenient to firm strategy.[69] Moreover, the interview

[69] Please see the well-organized scheme of global automotive industry given in Figure 20.

also involved questions on whether subsidized R&D projects have triggered new projects, more profits, employment and finally, exports.[70] The increase of exports towards sophisticated markets is a concern for us as well.

The findings show the indispensible role of the R&D for firm development. For example, BIG1 note that:

> *We have no unsuccessful projects on R&D. The only issue is there are some projects that have not been commercialized yet. The entire R&D performed within the firm have positive externalities for our core capabilities even if they generate no gains on profits.*

SME4 gave a parallel view with BIG1:

> *We cannot mention an R&D project as unsuccessful. A project can be in that kind only if it has failed to compensate outsourcer's needs. We have not run into any kind of problem like that until now.*

This is a striking quote to put emphasis upon. SME4 admitted that an R&D project is approved as successful when it fullfills the needs of the outsourcer. Upon this view, it is likely to assert that Turkish Automotive Industry accomplish the requirements of vertical integration. But it is questionable that this"success" criterion is sufficient to take us over the upper tiers of vertical integration in the global automotive industry. Our findings show that it is difficult to say so.

Another consensus attained by firms in the sample is about the success of R&D subsidies. They all agreed more or less with the success of the scheme of R&D subsidization in Turkey even though there were some recommendations for improvement. They, furthermore, havesimilar opinions regardingthe role of R&D projects on triggering new projects, exports and employment to some extent. For instance, FA1 outlined the benefits of R&D as:

> *After having licensed by the Ministry of Science, Industry and Technology as an R&D centre with reference to our R&D projects, we have come a long way on R&D. The firm as a branch of global MNE, has increased its gross revenue by 50 percent. We plan to increase our R&D personnel by 50 percent as well.*

[70] For a detailed discussion of externalities sourced by R&D subsidization, please see Chapter 2.

> *Actually, we are assigned for bigger projects on R&D and instead of assisting the main branch; we are now taking the initiative on those projects. Taking the projects from abroad has helped us take part in whole bus projects by using the advantage of R&D subsidies and being an R&D centre. One final positive development is we are about to take the global test and analysis centre in Turkey to be established by the main branch.*

This is in accordance with the findings of Erdil and Pamukçu (2011), prescribing the increasing tendency of MNEs to locate their R&D centres in Turkey, especially after the legislation of Law numbered 5746 for establishing R&D centres. Another striking success has been attained by BIG4, domestically-ownedfirm. They have very well-organized R&D centre that has not been so common for a domestic firm. BIG4 emphasized thatR&D efforts intensified after the separation of their foreign stakeholder in 2005. Eventually, they have concentrated on R&D by performing 20 projects for the last three years. They have participated different kinds of R&D subsidization programmes, both domestic and abroad, improving their collaboration with universities and procurers.

For SMEs, the effects of R&D are positive as well. For instance, SME5 claimed that their gross revenue has increased by 40 per cent with the accomplishment of two subsequent R&D projects. SME5 recently started to operate as a procurer of global OEMs.

On the side of exports triggered by R&D, the success picture remains. Most of the listed firms gave concrete results for their R&D-based export success, suggesting that the R&D projects improve export performance. Thisalso reflects the suggestions of Ulusoy (2003), emphasizing the excellence of Turkish firms in manufacturing high quality products for foreign markets. For example, BIG1 stated that they have begun to export fluctuating between 5 and 25 million euro a year- with the help of their R&D projects.[71] SME5 also emphasized the role of R&D on exports, noting that nearly half of their revenues are from exports. By noticing the significance of R&D to reach the phase of co-designer as a firm objective, SME4 stated 40 percent

[71] Please note that the export volume is fluctuating dramatically since firm is working on contract-based.

of their revenues are sourced from their exports. As a big enterprise, BIG4 exports 72 different countries, attaining 65 percent of its revenues from exports. BIG2 claimed that their exports increased to 15 percent of their revenues mainly because of the outputs of the R&D projects. In summary, by looking at the firms in our sample, one can deduce that R&D performance has a positive impact on exporting behaviour.

The discussion about the sophistication of the export markets is a little bit more complex.[72] Here, it is difficult to be able to discriminate if the export sophistication is achieved by the contribution of R&D.[73] To overcome this obstacle, we recourse to the concrete statements of the firms about the subject matter. Examples below outline the situation.

A concrete example for SMEs is SME5, claiming that R&D projects gave them the capability to innovate and procure for global OEMs. This enabled the firms to penetrate in to European markets. For big enterprises, BIG1 asserts thatR&D projects increased their capability of installing automation and robotics production lines to foreign branches of global OEMs. Also, BIG3 argued that R&D projects provide them to survive on their vertical relationships with global OEMs of heavy truck industry. In accordance, BIG4 and BIG6 also state that R&D and exports go hand in hand to sustain their global operations. For foreign affiliated FA1 and JV1, we see a similar story. These firms are in close contact with their headquarters, taking more assignments as their R&D capability advances. BIG2 is also confident that they can easily penetrate to more sophisticated markets with the provision of their R&D activities. These findings also refer to the increased capability of Turkish firms in reaching to foreign markets, however, as Ölmezoğulları (2011) put forward there still remains restricted conditions in terms of technological development, R&D project development, supply-side policies due to the dependent situation on global OEMs.

[72] Please note that here we call the countries of advanced economies like USA, EU and Japan as the sophisticated markets.

[73] Here, we do not mention about the contribution of R&D to the given firm's success as a business. The only interest of this part of the research is about whether R&D contributes firms to export more advanced economies.

Another important subject is about the decision-making of commercializing R&D output. The well-organized structure of the automotive industry dictates procurers and JVs its own commercialization contracts. The interviews with the selected firms also touched upon this issue of dependency, being very important to our discussion about technological sophistication.

The dependency of firms to foreing affiliates, partners, OEMs can explicitly be seen in the cases of BIG2, BIG3, SME2, SME3, SME4, SME5, FA1 and JV1. The common point of these firms is that their core businesses highly based on their vertical relationships with the OEMs. BIG2, BIG3, SME2, SME3, SME4, SME5 operates as a procurer to global OEMs. FA1 and JV1 are foreign affiliates. FA1 explicitly said that they are dependent on their decisions; however, on the contrary, JV1 claimed they are independent. [74] SME1 is dependent regarding commercialization because of its domestic affiliate. BIG4, BIG5 and BIG6 are observed as more independent to some extent because of their size and niche areas of specialization.

The final discussion of this section is of utmost importance. The evolution of performed R&D projects towards more sophisticated R&D activities is directly linked to our discussion on technological sophistication. In the definition of the term, our concern is about the capability development of firms in R&D such as assigning in more sophisticated R&D projects, evolving its R&D towards system development rather than component or single part and performing R&D in contemporary technologies. For instance, SME1 commented on their evolution in R&D projects as:[75]

> *Five years ago, we started R&D by designing sub-systems; but actually, our R&D projects are involved with system integration and whole vehicle design.*

[74]But the assertion of the thesis on Figure 10 falsifies this claim, pointing out the dependence of JVs to OEMs on their commercialization of outputs.

[75] Please note that most of the firms did not provide the whole list of their R&D projects and their context posed in interviews due to privacy reasons.

SME1 also provided the list of their R&D projects. Looking in detail to the R&D projects, we can argue that they have gone through an evolution of R&D that merits more sophisticatedknowledge production. This finding also supports the arguments of Atağan (2011), prescribing the increased capability of Turkish firms in reaching the phase of co-designer.

In accordance, by taking the data from the interviews, we can assert that some firms in the sample have managed to reach a more sophisticated level of R&D activities. For example, BIG1's current projects that have not been commercialized yet shows that their current level of R&D expertise has reached a critical threshold. A similar statement can also be put forward in the case of BIG5. SME4 is about to reach to the phase of being co-designer, which is a key capability to be attained for a procurer as Atağan(2011) suggests. Moreover, firmsBIG4 and BIG6 also show sign of conducting more sophisticated R&D prescribed by their global operations and niche areas of core competences.

On the contrary, for SME2, SME3, SME5, BIG2 and BIG3, we cannot claim a transformation in the direction of sophisticated R&D efforts. The common point that these firms share is that their areas of core capabilities are related to the traditional fields of automotive technologies. One can assert that the type of core competence is extremely effective on the development of R&D sophistication, supporting Assertion 2 presented in the preceding section.

In this perspective, as branches of global OEMs, FV1 and JV1 are black-box. We should state that FV1 is much generous to give information. FV1 claims that their R&D projects cannot be said to produce more sophisticated technological knowledgedespite their success (of pleasing the foreing partners). JV1 did not provide full information on the context of projects. We can only make comments that they have reached a critical threshold on R&D but we cannot claim they perform more sophisticated R&D due to lack of information provided.

To sum up this section, we have to following statements to conclude.

***Assertion 3*: The core competence of the R&D performers has a direct impact on the level of sophistication of knowledge production through R&D projects. If the firm operates in a core business based on contemporary technologies, it is more likely to observe evolution towards more sophisticated R&D and knowledge production.**

***Assertion 4*: Firms that are subject to the decisions of OEMs in R&D activities are unlikely to involve in the strategic decision-making regards to R&D and commercialization of outputs.**

5.3.3. Firm strategy towards innovation

In this section, we are to evaluate the core specialization areas[76] of firms in the sample to assess if they are prone to progress to areas that is characterized by more sophisticated technological knowledge. We assume that the inclusion of new technologically specialized areas in the fields of emerging automotive technologies might enhance the R&D sophistication of a given firm. Moreover, this chapter as well as Chapter 6 suggest that it is invaluable for a firm to advance its capabilities for designing systems rather than components or sole parts. For their technological progress, we perceive their application to the programme of TUBITAK in specialized fields (programme numbered 1511) as an important sign to determine their sophistication level of R&D. Firms' attempts to penetrate into niche markets and technological fields may be perceived as an endeavour to sophisticate their R&D performance. For the assigned projects by OEMs and JVs, taking specs as already given or developing its own design is an essential point to be studied upon since it is a considerable aspect to discriminate between R&D performers. It is also decisive in the sophistication of R&D projects. As mentioned, pre-competitive collaboration is an important sign to show that the firm has reached a critical

[76] Here, we define the term core specialization area as a bundle of skills, capabilities and technologies of a given firm, that limits or extents firm performance during their R&D activities. The term is derived from the theory of dynamic capabilities by Nelson (1991), the term of core competence by Hamel and Prahalad (1994) and Williamson (1995). For a good review of this terms, please see Duysters and Hagedoorn (2000). Throughout the study, widening core area of specialization by a given firm is assumed as a sign for technological sophistication in firm capabilities and R&D activities. Throughout the text, we use core area of specialization, core competence, core technology and core business interchangeably.

threshold on its R&D activities. In this section, we outline the findings of the interviews regarding these topics.

Among the firms in the sample, BIG1 clearly has shown the initiative towards including new specializations to their core capabilities. The projects for electrical vehicles and autonomous air service robots are of this kind. This firm aims at having an end product by adding certain kind of new capabilities to their core competences. In addition, firm BIG5 depicts the same initiative by designing an off-road 4x4 car, which is in fact new to its product portfolio. One can deduce that the initiatives of two firms are indications that these firms want to diversify their core competencies. But what is more important is that these new expertise areas are technologically more sophisticated compared to their current core businesses.

On the contrary, BIG3 has not been so fortunate on its attempt to expand its core business. Due to their expertise on mechanics, in their new projects concerning axle shaft with advanced manoeuvre adopted with electronic components, they are obligated to share the project with their partner having core competence on electronics. They have endeavoured to attain the capabilities concerning electronics; however, they have not managed it. This could be because of the reason that they lack capabilities or that they lack finances. Or it could be the case that core competence in a relatively more traditional technology is impeding to gain knowledge in a more sophisticated one. This can be referred as some type of technological lock-in, supporting the argument in Assertion 2.

For SMEs, it is harder to expand or change its core businesses by attaining new core competencies. SME5 stated its core business as producing plastic assembly parts for cars; however, it requires additional 5 million dollars investment to expand the business.Surely, one can regard this as a big investment for an SME.

There are two firms in the sample that have concrete attempt to move from component design to system design. These are SME1 and SME4, both pointing out their success to achieve this objective. One can assert that SME1’s project-based affinity to new concepts (being an engineering firm open to new developments and

concepts)may help further development on this aspect. We find engineering firms as vital agents for the development of national industry in this sense.

The source of the specs in an R&D project is significant as well due to reasons explained before. To some extent, most firms pointed out that they have benefited the specs provided by the outsourcing firms. The innovative projects mentioned above are of course exceptions to the rule (SME1 and SME4). But in general, these exceptions do not exclude us to assert the structure in the Turkish automotive industry that is highly dependent on global partners and outsourcing firms.

Most of the firms have already some attempts to penetrate into niche markets. BIG1's aforementioned new projects, SME1's new designs, BIG3's aforementioned endeavour for system design, BIG4's gel accumulators, BIG5's 4x4 vehicle and BIG6's projects for technical textiles are some of the examples. On the contrary, we should state that foreign-affiliated FA1 and a Joint Venture, JV1, are considerably connected to their headquarters on choice of product and R&D. This does not mean that they are not seeking for niche products; nevertheless, they have a solidpartner abroad interfering most strategic decions on R&D and innovation.

In order to examine the R&D efforts of firms in the sample, one final point to look at is their participation to TUBITAK's specialized R&D callsunder the programme numbered 1511 which were offered in selected high technology areas and the affinity of given firms on pre-competitive collaboration on R&D. BIG1, BIG2, BIG4, BIG5, SME1,SME4, FA1 and JV1 responded to the specific area calls of TUBITAK, participating the programme.[77] The others did not takeplace in the programme. The common point among non-participant firms is their expertise in traditional technology areas (except BIG6). The situation on the participation of firms on projects requiring pre-competitive collaboration is even more alarming. There is not a single firm stating an experience about the subject matter. This is another issue to be worked upon beyond the scope of this dissertation. However, it

[77]TUBITAK's 1511 Programme. Available at: http://www.tubitak.gov.tr/tr/destekler/sanayi/ulusal-destek-programlari/icerik-1511-tubitak-oncelikli-alanlar-arastirma-teknoloji-gelistirme-ve-yenilik-p-d-p

shows us that the current sophistication of R&D in Turkish firms does not really enable or support that kind of collaboration.

***Assertion 5*: Despite several positive attempts towards relatively more sophisticated and independent R&D activities, firms generally use ready specs from their outsourcers. Engineering firms are exceptions to this observation.**

5.3.4. Firm opinions about R&D policies in Turkey

As mentioned in Chapter 2, R&D policies are vital for the development of national industry. All the firms listed for the interviews are in an environment surrounded by different subsidization programmes and policies towards the development of firm-based R&D capabilities. So, we finally asked the interviewee his/her opinions about R&D subsidization policies in Turkey.

Firms have consensus on the benefits R&D subsidies to support private business R&D. For example, SME4 outlines the subsidies as given:

> *The government compensates its responsibility by sharing risks with R&D performers with the provision of R&D subsidies. We robustly claim that R&D subsidies in Turkey accelerate the efforts R&D performers.*

We can outline the recommendations of the firms as follows.

- More subsidies for industry-university collaboration,
- More emphasis on IPR of R&D for R&D performers,
- Supporting and empowering especially networking activities of Turkish firms with global manufacturers by enhancing knowledge flows,
- Subsidization of selected emerging technologies in a given roadmap.

One final note to emphasize is the industry's focus on subsidization rather than other aspects of technology policy.[78] The R&D subsidies are found to be vital for firms. However, firms rely heavily on subsidization schemes. The demand for and supply of more sophisticated tools of technology policy is rather weak.

[78] For a detailed summary of R&D subsidization policies and their tools, please see Chapter 2.

One can deduce that this is reasonable on behalf of firms since they are profit-seeking agents. It is further to be discussed in Chapter 7, policy recommendations.

To finalize this section, we can assert that:

***Assertion 6*: The subsidization scheme of Turkish technology policy seems to be beneficial to support the private R&D efforts. However, the demand for and supply of more sophisticated tools of technology policy is rather weak.**

5.4. Conclusion

In this chapter, we have outlined our findings from the semi-structured interviews held by a selected group of subsidized firms by TTGV. We have separated our findings into four groups introduced by sections and, for every group; we have made assertions about our current topic. Table 15 summarizes our findings including assertions and what they are saying about our mian concern which is technological sophistication.

In terms of R&D context, we argue that firms having core businesses on traditional fields of technology are unlikely to widen their R&D context towards more sophisticated fields due to their lock-in position backgrounded by their core businesses. Also, we assert that domestically-owned outsourcers or last-product manufacturers are more prone to disseminate their knowledge, emphasizing the significance of domestic leader firms. Rather than procurers, design and engineering firms are more open to widen their R&D context towards sophisticated products.

For R&D output, we determine strong presence of outsourcers and global OEMs on the decision-making of commercialization. Firms having core businesses on contemporary technologies are more likely to break down this restriction by sophisticating their R&D outputs.

We observe that firm strategies towards innovation including more sophisticated products and niche markets are furthermore related to the core businesses of a given firm. Firms on contemporary technologies have more opportunity to deepen their area of specialization. Turkish firms are used to get specs ready and given.

Consequently, transforming them into more design intensive processes requires time for progress.

One final point to note is firms focus on subsidization as we have asked for technology policies. Rather than subsidization, other tools of technology policy should be implemented to generate awareness over them.

To conclude, this chapter has given some clues to us on firm-level about why Turkish firms might not get sophisticate their R&D. In the next chapter, we are to pose our questions on macro-basis by attributing our assertions by macro-evidence.

Table 15 Assertions proposed by firm interviewees in selected areas of concern

Areas of concern	**Assertions**	**What it says about technological sophistication?**
R&D context	Assertion 1 and Assertion 2 on page 138.	The domestically-owned OEMs are more likely to disseminate their knowledge to domestic procurers. The rare presence of such kind of firms impedes the R&D context of Turkish firms to develop to a limited extent. One other reason impeding the national industry is the widespread presence on traditional technologies of supplier industries, impeding their advancement towards more sophisticated R&D.
R&D output	Assertion 3 and Assertion 4 on page 144.	Performing R&D upon contemporary technologies generates domestic firms more likely to sophisticate their R&D project outputs. Also, depending on solely the OEMs or global outsourcers might restrict their decisions on the commercialization of their R&D output.
Firm strategy towards innovation	Assertion 5 on page 147.	Turkish Industry is used to get specs outside rather than developing concepts especially on traditional fields of technology. This is an important point to brake down to evolve more sophisticated R&D-oriented strategies. Design and engineering firms seem as important agents to reach this end.
Firm opinions about R&D policies in Turkey	*Assertion 6* on page 148.	Domestic firms seem to get used to be subsidized. Other aspects of technology policies (more soft rather than hard financial subsidies) should be introduced to make them evolve towards more sophisticated technological fields.

CHAPTER 6

Expert Interviews for Auto Industry

6.1. Introduction

We have evaluated our data in Chapter 4 by using several indicators and hypotheses; then, we have put the findings from firm visits on micro basis. In Chapter 4, we have rejected our hypotheses concerning technological sophistication. R&D projects in our sample did not suggest us that there have been sophisticated efforts towards R&D activities in subsidized firms. As an impediment to sophistication, we have found out that the OEMs, as customers of Turkish suppliers, have significant effect on the decisions of domestic firms. In Chapter 5, we have further investigated the firms in our sample to validate some of the findings of Chapter 4. Firm visits and interviews with high status experts approved the fact that there is a strong presence of OEMs on R&D decisions of them as well as providing some invaluable insights as to how to overcome these impediments by using different approaches. Here in Chapter 6, the last point we would like to take reader's attention is the opinions and views of highly qualified experts about the history and macroeconomic conditions of Turkish Auto Industry. To this end, we held interviews with experts similar to firm visits, regarding their opinions about technological sophistication of domestic industry.

The interviews are supposed to provide several benefits. Firstly, we expect to attain more insights for the automotive industry from the experts by further understanding the sector we are trying to analyze. Secondly, by using their opinions about history, past policy experiences and macro economic conditions surrounding the industry;

we guess to find out some missing points in and complementary reasons explaining why domestic industry has not managed to sophisticate their R&D activities. It is supposed that the reason why we have failed in sophistication is possibly capable of providing some clues about our discussion regarding catching up, as well.

The discussions in Chapter 4 and Chapter 5 have offered us some issues to examine such as the innovation complexity of current R&D, transition to more contemporary technological fields, more sophisticated markets and products, OEM presence both as know-how provider and main customer, the choice between productivity increase or product innovation in current industry. To attain technological sophistication we have argued that domestic firms should activate more complex R&D projects with a high innovation level by passing into more contemporary technology areas of automotive industry. It might provide a way for them to penetrate into more sophisticated markets such as EU, Japan and the USA. In terms of our prescription for technological sophistication, they should achieve this objective with less dependence on OEMs' decisions in global industry by increasing their capabilities in know-how provision and becoming independent, to some extent, on their decisions of commercialization.

In this chapter, in addition to the issues discussed above[79], we have opened up related discussions under the headings of macro conditions and global trends surrounding automotive industry, policy measures (industrial policy focusing on R&D funding, subsidization measures and catching up) in history of Turkish Automotive Industry and the comparison of it with foreign countries. These are all to be discussed in this chapter in the scope of technological sophistication. Subsequent part shows us a brief context and methodology of expert interviews; and then, we discuss the findings from experts in accordance with our purpose. In the conclusion part, we outline what refers our findings from interviewees about technological sophistication.

[79] We group them as "Findings for Current Turkish Automotive Industry" in this chapter.

6.2. Context and Methodology of Expert Interviews

This section aims at explaining how expert interviews were held through dissertation studies and the goal of expert interviews that are considered to be the baseline of macroeconomic views on Turkish Automotive Industry. We have also asked about questions on firm-level to enhance our understanding in Chapter 5 and Chapter 6.

In this section, we briefly explain the context of interviews we held. At the beginning of each interview, we organized a meeting up lasting for five minutes. We asked the interviewee about his/her career to understand his/her career path of development in automotive industry or related fields. The meeting up was important to understand each other for both interviewer and interviewee. We, then, explained why we were realizing interviews in the context of dissertation studies. The core part of the interviews was surely the questions in which our objective was to find out new insights for the rest of the dissertational studies. We planned to ask the historical background of the sector in Turkey, the ongoing structure, R&D and R&D funding and finally, catching up and sectoral position in the global industry.[80] Furthermore, as the core part, we looked out how the findings could be evaluated or validated by further studies.

Another issue to cope with was how we could select the professionals for interviewee list. We drafted a list of about 20 high status professionals from automotive industry by respecting their backgrounds and their influence in the sector. In this selection, also recommendations from both thesis committee and opportunity to take appointment were taken into consideration. Interviewees were mainly from automotive industry; but, so as to sustain outward looking, we also chose a high status professional – retired and well-experienced- from electrics industry which we think is one of the most promising sectors for the automotive with its potential of creating high value-added as it is combined and integrated with contemporary automotive technologies.

[80] The questions posed in expert interviews are given in detail in Appendix D.

Table 16 List of Expert interviewees by their features

Interviewee	Title	Firm/Institution	Rationale behind selection
Int. 1	General Manager	University test/homologation centre	The expert is highly qualified.
Int. 2	General Secretary	An umbrella organization	The expert is a well experienced and well-known in auto-industry
Int. 3	General Manager	An R&D design/engineering firm affiliated with an OEM.	The expert is a well-experienced specialist in auto industry.
Int. 4	R&D Director	A JV in Turkey	The expert is well-experienced by his R&D management.
Int. 5	Technology Consultant	Ex-R&D Director of a bus manufacturer; Technology and Strategy Consultant	The expert is well-experienced; also an entrepreneur and consultant
Int. 6	Professor	Ex-R&D Director, an academic member in a university	One of the first R&D managers in Turkish Automotive Industry
Int. 7	R&D Director	R&D director in a Turkish manufacturer	The expert is a well-experienced specialist in Auto Industry.
Int. 8	Technology and Innovation Consultant, Automotive Specialist	Ex-Senior Expert in R&D funding, Automotive Specialist, Technology Policy Maker	The expert is well known with her opinions and reports in the community of automotive industry; also one of the ex-policy-maker of Turkish very first R&D grant programme.
Int. 9	General Manager	Ex-manager in an EU programme, General Manager in a consulting firm	The expert is specialized in networking and clustering.
Int. 10	General Secretary	Technology Specialist, Business Developer, General Secretary in a formerly R&D-funding institution	The expert is a technology specialist, business developer, highly skilled official, having wide array of knowledge and vision about several sectors and technologies
Int. 11	Ex- Board President	He is a guru of Turkish electrics and electronics industry, the founder of nation's very first R&D department in electronics.	He was selected for interview because electrics and electronic industry is considered as having important complementarities for Turkish Auto Industry.
Int. 12	General Manager	Manager in a automotive procurer	He is highly experienced in auto supplier industry
Int. 13	Vice Manager	Financial manager in an engineering firm	Well-experienced professional in automotive industry
Int. 14	Ex-General Coordinator	An umbrella organization of Turkish Automotive Suppliers	Well-experienced professional in the supplier industry

Finally, there remained 14 professionals to be appointed, due to several impossibilities[81], whole list could not be appointed. Moreover, we considered to

[81] Two of them did not accept the appointment due to their busy schedule.

interrupt the interviews as we decided that the opinions of experts converged as we did in firm visits. The proposed expert list for interviewees is given in Table 17. In the list, a reader could find out information about the interviewee, his/her title, his/her firm/institutions, rationale behind why he/she was selected.

Except Interviewee 1, we interviewed each expert one time. Due to his valuable opinions, suggestions and assistance, Interviewee 1 was talked twice. Each interview took between 30 minutes to 1 hour in regard to the interviewee's schedule. We asked the interview questions in a semi-structured format. In the next section, we are to represent all the findings by respecting the topics we have selected.

6.3. Findings from Interviews

As previously explained, in this section, we aggregate our findings in appropriate with sub-headings. At first, we begin by explaining the opinions regarding macro conditions in global automotive industry that would be cooperative to draw a framework to understand the views and opinions by interviewees about the historical background and implemented policy measures in Turkish Automotive Industry. Then, we think of passing into the discussion of history and current conditions surrounding the industry, reflecting the views about current position and future recommendations of experts. We finally establish a comparison between different groups of countries and Turkey.

We draw up our findings from interviews; sometimes by quoting or sometimes by narrating the findings by ourselves to sustain the integrity and completeness of the explanations. In the final part of each section, we form propositions to outline our findings.

Now, we are starting by macro conditions and current structure of global automotive industry.

6.3.1. Macro conditions and global trends surrounding Automotive Industry

Up to now, we have severally argued that there is a well-organized scheme in automotive industry. Here, what might this argument claim? What does well-

organized mean? As a definition, a well-organized industry refers that there is a strong entry-exit barriers, pursuing by a high amount of consolidation between agents that plays in the foreground of the selected industry; and a global value-chain that is composed of very pre-determined profit margins, not differentiating much between countries because the main agents leading the industrial field have the power of deciding what part of the manufacturing process would be allocated to the sub-tiers of the procurer countries.

Interviewee 1 made invaluable contributions to the definition above by prescribing the current organization as:

> *There is a well-organized scheme in automotive industry. A branded car is manufactured at a cost of 75 percent of its sale price. Then, JV has rights to sell it to a dealer or export it with 3-5 percent margins. Main branch of the JV is determining what part of the production is sold abroad and what part will remain inside. JV has rights to sell the part that is left for the domestic market with a margin of extra 12 percent. Then, for a car sold in domestic market, the profit margin for JV is reaching nearly to 17 percent. The last 8 percent part is acquired by the dealer. From this scheme, the growth of domestic market refers more value-added for JVs.*[82]

We have summed up this assertion as a simple figure given in Figure 10. We strongly assert this quotation and Figure 10 explicitly reflects the global organization currently sustaining. Also, it gives precious clues about the dependence of JVs on main brands in decision-making. We have become aware of that JVs are bounded to their main branch even on the numbers of cars to be sold out in domestic market which offer the best profit margin for the bounded JV. One can, moreover, deduce that JVs have no decisions on their own even for the domestic market for which they have the best penetration capability. This finding is important for our debate over technological sophistication as this well-organized scheme is capable of restricting initiative of national industry towards technological sophistication. It is also supporting the view of Ölmezoğulları (2011) who emphasized the restrictions of JVs

[82] This quote is explaining why obtaining value-added from a JV would not give much information. The quotation explicitly reflects the well-organized scheme for JVs operating in Turkey and furthermore, in global industry, as well.

on Turkish automotive Industry. Moreover, this finding is in parallel with the views of Pamukçu and Sönmez (2011) who explicitly questions the knowledge-intensive interrelationship between Turkish firms and global OEMs.

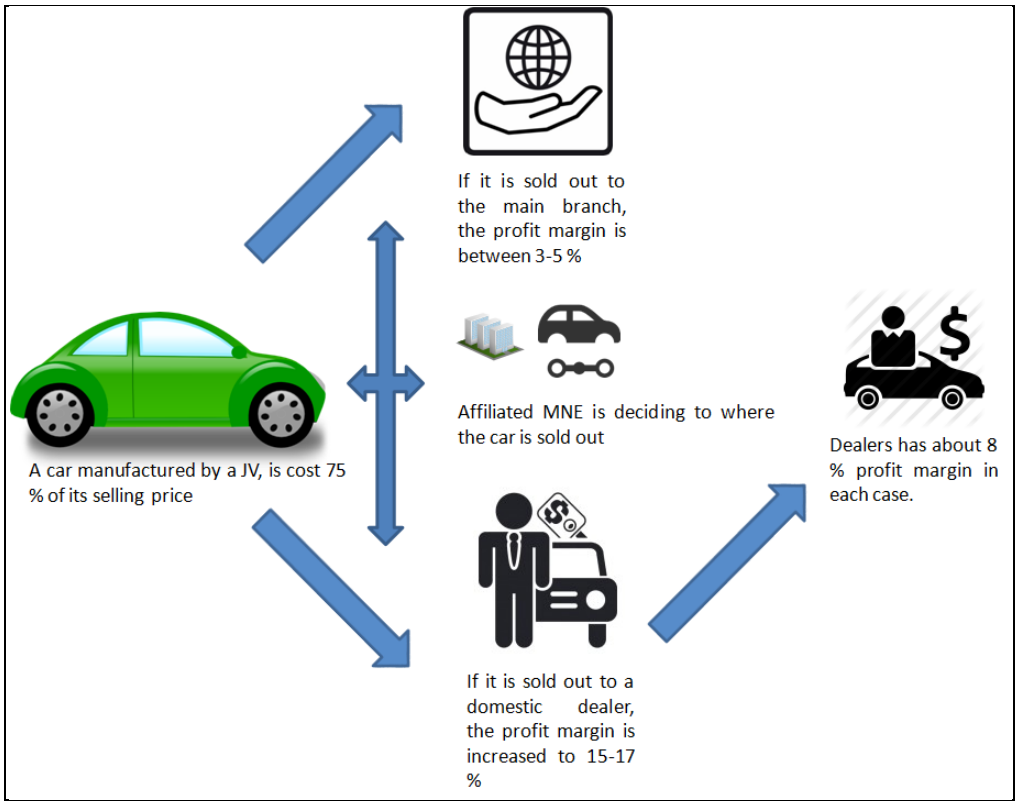

Figure 10 The profit margins in a given branded car produced by an affiliated JV as outlined by Interviewee 1

In this scheme, Interviewee 1 additionally outlines the linear flow in auto industry. The workflow in auto industry begins by raw material procurers. They are procuring for suppliers in Tier 1, 2 and 3. Those all tiers produce parts, components and systems for OEMs. Finally, OEMs sell out their end products – cars to the dealers and the complete workflow is closed in global value-chain.

Interviewee 1 stated that chassis, door, roof and many other parts involved in cars are manufactured by OEMs. This statement is significant as it puts forward the general functionality and placement of OEMs in global value-chain.

We have, in addition, posed for what are the suitable ways for a JV to increase its profit margin; Interviewee 1 responded as:

> *JVs have very lower unit prices per parts. In a JV, for cars exported outside, JV has the profit of 3-5 %. If the car is sold outside, JV is earning additional 12% and reaching the amount of 17%. But, how many units are going to sell outside and how many are being left inside is determined by the decision of main branch. Only if you have royalty, you might increase the share you are earning from the sale of a car.*

This opinion of Interviewee 1 is invaluable for putting forward the reality, suggesting R&D processes and getting Intellectual Property are important tools for standing alongside the global automotive industry; particularly for a foreign-affiliated JV.

Interviewee 8 also took the view in line with Interviewee 1 by claiming that:

> *Today, it is not hard to manufacture an automobile. The focal point is in what you are specialized, in which part of you are locating in value-chain and your capabilities that creates competitive advantage in global industry. Marketing globally is a hard challenge to cope with.*

Figure 10 simply shows up the fact that you have four different possibilities to increase your value-added as a JV.

1) Having royalty in some parts of the car or as a whole to increase what you get from an export,[83]
2) Increasing productivity by the increased automation, labour exploitation, and procurer exploitation or by increasing the capability of your procurers with the reciprocal exchange of know-how (like in Toyota case, Womack et al. 1990),

[83]For the dependence and revenue deficit of Turkish industry on imported and intermediary products, please see Samsunlu (2007) and Gülşen (2007).

3) Positioning in another part of the value-chain such as setting up your own dealership network to have more value-added or as increasing your tier up to take design intensive processes for a product you procure,
4) Lobbying and influencing main branch for both having R&D projects in some parts of new models to have royalties or taking allowances for penetrating the domestic market with more cars.

In addition to the views of Interviewee 1, Interviewee 8 also stated the eminence of having royalties as such:

> *Design and design confirmation are the most eminent processes of automotive manufacturing today. If you have presence in design, you take royalty and as a result, higher positions in global value chain.*

This quote evokes for the study of Atağan (2011) which clearly explicates, for several suppliers in Bursa, reaching a co-designer phase has given them some space in the upper segments of global value-chain. Moreover, for productivity and positioning upper parts of the value chain, Interviewee 8 also added up that original equipment manufacturers, suppliers and engineering firms are at the top of the value chain, emphasizing the fact that, in leading automotive countries, technology development and design intensive processes are being realized by suppliers.[84]

Another concern might be taking R&D projects by lobbying activities and building domestic capabilities. Here, the question is why a JV, operating in Turkey, should build up capabilities and take R&D projects from headquarters? For taking R&D in-house and benefiting from it, Interviewee 6, who knows the start of the Doblo project very well, pointed out that:

> *In TOFAŞ, Doblo was the very first car that was fully designed and manufactured in a JV in Turkey. TUBITAK supports were effective in manufacturing the prototype. R&D department in TOFAŞ had been started up with 10-15 persons and then, it dramatically increased to 350-400 persons.*

[84] Toyota is the best example for this. Please see Womack et al. (1990).

Then, this argument makes us consider the fact that taking R&D projects from headquarters might give the capability of triggering in-house R&D activities of domestic JVs. Predominantly for developing countries requiring more sophisticated projects, it is crucial to obtain critical threshold by attracting R&D from global agents. Though, the quality of R&D projects and their sophistication is also important as Interviewee 3 responded. Interviewee 3 strongly claimed his consideration about having all the design parts or work packages of R&D projects rather than single part by saying that "If only a simple part of the R&D project is operated through the JV, it means they 'dance' with each other and no exceptional benefits offered for domestic JV". As Interviewee 3 emphasized a holistic vision of R&D projects, we assert the finding of not solely attracting foreign R&D, but also the increasing eminence of their context and the holistic notion that should involve them. The performers of R&D, rather than "dancing with foreign affiliates", should be involved in comprehensive and extensive relationships in order to benefit from outsourced R&D by OEMs as realized in Doblo case mentioned above. It requires an increase in quality of interrelationships between Turkish firms and global OEMs as Pamukçu and Sönmez (2011) argued. Similar to the arguments of Ekmekçi (2009), it would also be helpful in alteration of low value-added production with "high value-added, original and branded-designs" by transforming current excellence in production capabilities into design capabilities.

Understanding the current well-organized scheme is considerably important. So, additional questions should be posed such as: how is the interplay taking play between agents? What are the prominent players and processes shaping the automotive industry? How is the competitive advantage attained? Interviewee 1 responded this as well:

> *OEMs are gaining competitive advantage by styling in which there is a fierce competition. More than half of the money is paid for status and established brands. Thus, OEMs are not working on sub-components and outsource them to the suppliers. OEMs are collaborating with suppliers on raw materials and production lines. Sub-systems and components are being made in supplier industry. OEMs are sharing know-how with them – this refers the strong fact:*

real value-added means that real supplier industry. Critical innovative products integrated with software should be designed and supported in current situation.

This explanation describes the interplay between OEMs and supplier as the central decisive factor to create value-added by asserting the know-how exchange among them. This seems as the factor behind the scene based upon the reciprocal dependence on each of the agents: OEMs and suppliers. Integrating software also emerges as a vital element to gain value-added. It also reflects our discussion in Chapter 2, Chapter 4 and Chapter 5, prescribing the eminence of integrating electronics with current automotive technologies.

Here, another question to pose is where we might put design and design confirmation processes in this reciprocal relationship between OEMs and suppliers. Interviewee 8 answered this as:

While designing concepts, at first you should collect data from the field – signals from markets, passengers, car users, dealers, manufacturers etc, so that you are able to design brand new models accompanying the needs of stakeholders. Then, that data help you design new concepts. However, developing countries such as Turkey are skipping this phase of design since the designs have been readily served by JVs operating in the selected country. Without market analysis, it is impossible to develop concepts.Furthermore, design confirmation is as important as design. It is rather complex and difficult. I had realised this fact during my work experience regarding R&D funding. And simply, a highly-disputed notion - brand is created in a single line as;Design confirmation => Criteria set-up => Measurement

Determining these and mixing them with regulations and homologation processes are keys in establishing and sustaining brands. However, unless you reach a certain level of expertise, you do not have a say in this process.

From the quotation, we deduce the vital importance of concept design phase in design and design confirmation processes. Unless a JV collect data from the field, it seems impossible for it to participate in design. We assert this as an invaluable finding particularly for the case of Turkey. The fact is that Turkish JVs are highly dependent upon their designs of their foreign affiliates; it seems rather difficult for

Turkish manufacturers to participate in decision-making processes. They are also unable to participate in confirmation, regulation and homologation processes. This, moreover, impedes the establishment of a national brand because there exist no opportunity to participate in the decision-making of current industrial trends. This finding is concurrent with the findings of Ölmezoğulları (2011), stating the some kind of lock-in situation of Turkey on co-designing activities. One final thing to add up is the argument of Interviewee 1 arguing the significance of business models with increasing R&D expenditures: "If we assume that total revenue is increased by total R&D expenditure and even with this increase does not trigger firm's profitability, there seems some problem in technology or business model". This statement emphasizes the significance of convenient business models for automotive industry. We assert this is a crucial point as we consider the ignorance of business models in Turkish Industry in which firms give the real emphasize on invention or R&D.

Interviewee 3 picks up this by comparing brands with JVs and simply asserts that "JVs are capable of doing incremental innovations while brands are trying to do radical innovations". The inherent nature of JVs with their lower capability of design disallows their affinity to realize radical innovations. We strongly consider this as one of the reasons, explaining why Turkish Industry has not increased its technological sophistication as shown by TTGV data in Chapter 4.

We surely think the quote by Interviewee 7 concluded up the current structure as given:

> *For a business group in car industry, it should have product portfolio that is regularly sold in high volumes to gain considerable amount of revenue. Common transport is still on four wheels. Boundary conditions are certain and in this well-organized industry, corners are held by big players. In main industry, the needs are determined and the prices are fixed. Turkey has accepted the rules that the western counterparts has established and has no power to change them from now on. Developed countries are continuously changing and developing these rules in order to protect their leadership positions.*

By this quote, we perceive a well-established industrial structure that is having high entry-exit barriers with no field for newcomers and key roles had been shared by the

developed nations. With the same technological development agenda, it seems little opportunity for Turkey to catch up. Turkey seems to follow same path of development as the forerunners.[85] New ways of doing things regarding different emerging technologies and business plans should be found.

At this point, we should ask what the current technological trends and forecasted technologies for the future are. Not only the current structure outlined above but also the global trends emerged in the industry is important. Interviewees have also given some invaluable insights about the current trends in global automotive industry. In the following, we shortly explain them.

The first issue to discuss is the global technological trends in the industry. But at first, under the general scheme given above, Interviewee 5 shows up a striking point in the current industry:

> *Given the ease of reaching capital, investment, technology and resources today, design and innovation are of vital importance to provide competency in global industry. It is not hard to find money and technology.*

We strongly assert that this is a good starting point while considering the role of technology in automotive industry. This quote does not mean that technology is unimportant. Rather, it refers to the fact that technology is of significance as it is combined with innovation and design. Interviewee 1 clears this discussion as quoted:

> *There are two different groups of tendencies in automotive industry:*
> *1) Value-added acquired by technology: cast and sheet parts, embedded electronic systems, glass technologies, polymers etc.*
> *2) Customer-based tendencies: comfort (heating, air-conditioning, seats etc.), entertainment, interior design, exterior design, safety (ABS, ESP etc.)*
> *From the tendencies, sectoral players should foresee the future, and play their cards in accordance with their forecast. It should be known that which concepts are developing and which concepts are dying.*

[85] Please see our discussion on technological development and catching up in Chapter 2.

Here, one can deduce that, when we talk about technology, we are considering the value-added gained by process innovations and high technological innovations based on system design with emerged technologies. But they should turn into innovations by adopting them with user-friendly interfaces with ease of use by the customers.[86] Moreover, customer-based tendencies mainly based on design of cars are also important as an emerged tendency as we notice increasing differentiation in car models. Hence, global brands are focusing upon styling determined by customer preferences. One final point to emphasize from the given quote is the strategic decision-making of auto manufacturers by forecasting future since the technological trends and customer tendencies are highly decisive in global trends.

Thus, under these circumstances, in terms of technology, what are emerged trends? Interviewee 1 outlines emerged trends related to technology as to design light-weighted, environment-friendly car with less fuel consumption and good safety convenient to regulations. He prescribed system design and dividing lower parts as the most important activities in the industry. Then, he adds up his related comments for the future as: "Light-weighted vehicles should be at the focus rather than electrical vehicles. Cars will be downsized; lighter and smaller engines, transmissions will be at the focus".

This quote emphasizes the trends, for a given car, as being down-sized and light-weighted with lower fuel consumption and more safety. This can only be realized by newly emerged technologies based on new materials and nanotechnology. Regulations, with their increasing presence, will play a crucial role in determining the future trends. Interviewee 3 supports the opinion upon the significance of foresighting the future technologies in the industry by emphasizing the importance of trend-watching and determination of future products.

The opinions from interviewees also put forward the significance of engines as both current and future technologies. Interviewee 3 stated that:

[86] Please see the difference between invention systems and innovation systems outlined in Chapter 2. Metcalfe (2007) offered innovation system as a bridge between invention and market systems.

> *For engines and transmissions, you should at least manufacture 500000 or 1 million units to make that investment feasible. That is why brands produce same type of engines for different kind of models in different segments. They are realizing little changes on the main body of engines and produce different kinds of it with different specs.*

Engines seem important and also would remain the same for the future. This is a crucial point to be evaluated by sectoral players. In addition to engine technologies, as Interviewee 6 stated;

> *Body analysis is required for producing better cars. And, for example, ABS design is not harder than body design. Recently, embedded software, electronic features and some safety and aid component and designs like parking assistance are at the hotspot. Electronics industry is a prerequisite for producing "smart automotive systems". Without a good electronics and software industry, it is impossible to design and produce engine control unit.*

This quote also asserts the key role of the presence of electronics technology in current and future automotive technologies as well. Smart system designs, mainly involving and requiring electronics, are prominent factors in customer-friendly innovations adopted in cars. This fact compels us to consider the situation of Turkish Electronics industry and its adoption with the national automotive industry. Interviewee 11 shortly and wisely explains the situation of Turkish Electronics Industry and its relation with the automotive as:

> *There had been great challenges in Turkey as we concern electronics at the very starting point. The non-existence of physical infrastructure, qualified workforce and intellectual capital could be counted as prominent factors. With the support of government initiative of that time, the very first R&D lab in a public company had shown the very first R&D efforts taken place in an R&D department within Turkey. By 1980s, we had come to critical threshold; but unfortunately, privatization imposed by the government policy had slowed down the national efforts towards electronics. As we speeded up in automotive industry, there passed a considerable time in the decline of Turkish electronics. I strongly think that the failure in adoption of electronics technologies in automotive has decreased the value-added being created in national auto-industry, particularly*

within suppliers. This has also impeded the system design processes. The result is products with lower value-added.

This is a striking view to be considered. The role of electronics in automotive industry is irrefutable and, in a car, the presence of electronic components has been increasing steadily. But, Turkey seems to have ignored the strong effect of electronics it might have on the development of her national automotive industry. As policies towards privatization, particularly emerged after 1980, were measured, the national industry was getting weakened, particularly in hardware and component development. The adoption of capabilities accumulated in electronics has been crucial in automotive industry, suggesting non-existence of such a crucial part in competency regarding to automotive. Interviewee 6 also agreed upon this topic and commented on the emergence of electrical vehicles as;

Surely, in automotive industry, the weight of electronics is continuously increasing. In this manner, rage extension is another important problem to be solved in electric vehicles. Range-extension (range-extended engines) is a technological field of specialization in the future.

Interviewee 9 extended the discussion by stating some additional comments about the future of automotive industry. According to this interviewee, electric vehicles seem to be dominant in the future and, in contrast, H2 (hydrogen) driven cars do not seem to be a hot prospect. Internal combustion engine technologies will be dominant until the sufficient returns are collected from investment. Efficiency growth is possible during this period. Moreover, Interviewee 9 emphasized the fact that, in electric vehicle technologies, there are some unknowns such as how customers will react to non-voice engines. This interviewee exemplified this by mentioning BMW; which is currently working upon virtual engine voice in order to provide customer satisfaction.[87]

Given the customer satisfaction in other challenges for the adoption of electrical vehicles, the attainment of rage extension targets seem to increase the possibility of

[87] Electric vehicle technologies offer considerable opportunities for leapfrogging in automotive industry. For a discussion, please see section 2.2.4. and Wang and Kimble (2013).

substitution of internal combustion engine technologies with electrical engines and it shortly means electronics technologies would reach to the heart of automobiles. This also suggests electronic technologies with other related technologies like batteries, control units, software, electronic transmission etc. would cover the whole components of cars. This is a well-fitted point to consider about the future of the industry and, as a country, what you are missing unless you develop competencies in car electronics. This is a view to be dwelled upon while considering Turkish case.

Another issue to consider is the globalization and internationalization of the industry. Interviewees also suggested some invaluable insights for the topic. How does the globalization shape the current structure of the industry? How is it likely to evolve for the future? What are the effects of globalization on R&D projects? What are the roles of suppliers in this global network? For these and similar questions, we found out some answers as follows:

The first issue to discover is the blurred boundaries in global value-chains, particularly in automotive industry, for the national borders.[88] Interviewee 8 states this as follows:

> *As globalization paces, the system continuously changes. National borders have disappeared and no term remains like "interior" and "exterior". There is a consolidation between global brands. There seems to remain 5-6 consortiums that are producing cars. Notwithstanding any borders of the nation states, the trade volumes are considerably augmented.*

If the system is so blurred, another question to ask is how the R&D projects are performed? Are they performed by consortiums, MNEs etc.? On which specialization or technological expertise are they intensified? What are the roles of suppliers in this sense? Interviewee 9 answered this as:

> *Among international projects, the most important ones are from the technological fields of telematics and telecommunication. Innovative projects are not being developed within the sector. For international projects, innovative*

[88]It is also related to the distributedness of innovation (Coombs et al., 2004) in the current literature as proposed by Chapter 2, section 2.3.2.3.

> *ideas are coming from SMEs and Research Centres. Main car manufacturers are operating as test-beds of these projects. There occurs a consolidation between high-tech and middle-tech. ICT-driven technologies and manufacturing technologies are driving innovation in automobile industry. Recognition in cars, customization, ICT and safety seem as hot topics in automobiles. OEMs do not participate in creative innovations in these fields of technology and leave them to SMEs and Research Centres.*

This quote again proves the increasing importance of electronics in automotive. Innovation is sourced by SMEs and, OEMs and MNEs are operating as the "gatherers of innovation". This fact also emphasizes the importance of open innovation in the sector and in its global network. Interviewee 9 continued his comment as: "In the future, open innovation a key fact concerning global industry. There seems to occur convergence in key technologies. EU seems to protect its strongest position in the industry".

Open innovation which is built upon increasing coordination and communication between the agents of the network seems to emerge as the dominant way of performing R&D and innovation. The isolated efforts towards innovation seem to have completely disappeared in accordance with the theory of innovation systems[89].

In this process, the role of SMEs as suppliers is another concern of us. As a starting point, Interviewee 9 also explained the position of suppliers in global network of automotive industry as:

> *Only OEMs are not enough to develop the industry. Also, it is strongly required to establish global supplier trademarks and suppliers operating globally to further develop the national industry.*

As stated earlier, the best example for this is the Toyota case. As Womack et al. (1990) explicitly analyzed, Toyota realized its efficiency and profitability by transferring know-how to its supplier network which was widely based upon trust and commitment of both parts. We further see that successful countries in auto industry are not only having competence with their national auto manufacturer

[89]For evolution of the understanding of the term "innovation" by the current literature, please see section 2.3.1. in Chapter 2.

brands but also with their suppliers in supplier networks which are also branded in the global industry. In this sense, we consider Atağan (2011)'s positive arguments towards competitiveness for firms in Bursa as a prospecting findings for the future of national industry.

We would like to conclude this discussion about current trends in global industry without neglecting to discuss the topic for having a national brand. This topic has been widely discussed in last few years, particularly appointed as an agenda by the political authority in Turkey. The experts we have interviewed are not optimistic about this possibility since there is a sustaining consolidation in the industry which augments the entry/exit barriers a lot. Moreover, as Interviewee 1 stated below, after the globalization period, it is hard to establish a service network for a given car brand:

> *We can review the main difficulties to have a car brand are about two factors: 1) Scale economy (financial problems) and 2) Logistics and services. It is hard to have a service network for a brand established from scratch.*

Even if, as a brand, you overcame the challenges concerning scale economy, you would also have problems about the establishment of service network. For instance, it would not be so easy to persuade foreign-service providers for your brand which was newly-emerged in global market; and even if they were persuaded, it would require high costs to educate personnel and establish network in a country that you did not know. This simple example shows the practical obstacles you may encounter in a venture for establishing a global auto brand. This is shortly means that not only financial or scale economy reasons take part but also practical reasons to overcome put on great limits in today's automotive industry with its high consolidation and financial volume.

To conclude up this section, we make several assertions:

***Assertion 1*: Current global automotive industry has a well-organized structure with high entry/exit barriers and pre-determined profit margins that are**

consolidated by big players allowing little space for the latecomers such as Turkey.

***Assertion 2*: For latecomers such as Turkey, obtaining royalties to perform design intensive processes of R&D and establishing competency in system design involving electronics could enhance further technological development.**

***Assertion 3*: Since the competency of the suppliers is eminent in the automotive industry, Turkish automative industry should network with the MNEs to transfer know-how.**

6.3.2. Policy measures in Turkish Automotive Industry

Automotive industry has always been a hot topic in Turkey. Our interviewees answered to our questions in interviews, pointing out the breakthroughs in Turkey according to their understanding. In this section, we quote them in accordance with our concerning topics as we did in the preceding section.

The first issue to discuss is industrial policy. What has the sustaining evolution of policy measures towards automotive industry? What are the successes and failures? What are the breakthroughs? Now, we are to discuss them all.

The ever first policy measures commented by interviewees is reaching to import substitution policies and Devrim case. The launch of the ever-first Turkish car, with its whole components designed and prototyped in 1961,was a command of the military after the military coup of 1960 had taken place. It was a top-down government initiative and reputative engineers of that period were assigned to accomplish this mission.

Interviewee 3 commented for the surprising initiative of handling Devrim project as:

> *Devrim case was a spike in the history. It had made in wrong time and in wrong place. Turkey had no sufficient intellectual capital in that period of time. There were so many bottlenecks in industrial structure.*

This is an invaluable comment showing the situation of industry in that period. Even building a project team was hard to be attained and it was imprecise what would

follow after a successful prototype had been launched. The competencies and qualified workforce had not been built. The supplier network was nearly non-existent.

Interviewee 5 also noticed the concerns above as given below:

> *At 1960s, almost every country had its own venture on manufacturing domestic car. On Devrim case, Turkey had made the wrong decision and made the wrong choice as well. In their memorials, Suna Kıraç and Vehbi Koç explained why they had not invested on domestic cars, showing the lack of intellectual capital as the main reason. For example, Vehbi Koç explained it was too hard to establish even a canned food plant – an industrial venture requiring so much lower capabilities with respect to car manufacturing.* [90]

Moreover, understanding that period of world conjuncture is significant. While comparing 1960 with today, Interviewee 3 asserted that:

> *As Turkey manufactured Devrim, there was no consolidation and there were too many car brands operating especially within national borders. However, in the past 20-30 years, there has been a great consolidation among car brands and this consolidation has also involved the OEM and supplier industries as well. The result of the consolidation was the rise of entry/exit barriers for the newcomers in the industry. It also impedes the process pf catching up for the latecomers.*

Of course, the sustaining political paradigm of that period is also important. Interviewee 5 continued his comment as drawing the main frame of Turkish Industrial policy: "Starting with the 1960s, Turkey has never laid aside its 'heavy industry movement'. From left or right wing, every ruling government has tried to implement the policies towards this end".

In 1960, the ruling policy was import substitution. Our interviewees, furthermore, commented on the effects of import substitution measures since it was a considerable milestone shaping the industry in those days. What was the essence of implementation of import substitution measures? How did the government intervene in the auto industry? How did those interventions affect the industry? Interviewee 5

[90] The interviewee gave citation to Streather (2011) for his comment.

answered these by mentioning the facts as follows: In Turkey, once the auto market had been set up, the production process followed. In closed economy, there were some infrastructure shortages, political and bureaucratic problems restricting the industry. The government also supported the industry by subsidizing business groups of Koç, Sabancı etc. in order to provide capital accumulation to foster the investment environment. Customs and tariffs encouraged these measures. As the great problem of closed economy, products having poor quality had been widely sold out through the domestic market. As discussed in Chapter 2,Ölmezoğulları (2011) considered the period of import substitution policies as an impediment to further development of today's Turkish Automotive Industry.

In contrast, Interviewee 8 resumed by stating the beneficial results of import substitution measures. As far as this interviewee was concerned, implementing several measures to support the industry in this policy scheme, domestic industry had reached a certain level of capital accumulation. Also, with the help of assembly production, industry had reached a certain level of expertise in production.

Given these quotes, we might refer the import substitution period as an attempt to build competency by accumulating capital in different business groups. Several business groups had emerged and expanded their businesses thanks to the subsidization and protection of the government. Particularly, one can claim that this period was useful in building a capacity which was non-existent in Devrim case in 1961. Moreover, as Interviewee 3 stated, import substitution policies enforced national industry to be able to perform assembly process in car manufacturing.

The import substitution policies had been measured until 1980 and, as Interviewee 8 emphasized, this year was a breakthrough. After the coup of 1980, with the new ruling party of 1983, Turkey began to implement export-oriented policies for the industry, aiming to establish open-market regime throughout 1980s. Interviewee 8 commented on this as:

> *Breaking point was 1980s. Without any market search, it was impossible to have new markets. In the beginning of 90s, GATT Tariffs have also been implemented. During these periods, as well as export emphasis, it should also*

be focused on R&D efforts but Turkey had neglected this notwithstanding the negative effects of open-market policies on its infant industries.

This neglection had precipitated the automotive industry as well. However, the export orientation and openness to competition had triggered awareness on industry side to compete with global players. In this phase, the establishment of TTGV, its R&D support programme in 1991 and the launch of TIDEB of TUBITAK had helped to improve Turkish industrial ecosystem by subsidizing the industry. Interviewee 3 made invaluable comments about how Turkish Auto Industry was able to overcome this bottleneck:

In 1996, with Customs Union Agreement, industry had faced a serious challenge to survive. There was an expectation that Turkey could not have endured the fierce global competition. For example, Koc's 2000 Vision had been about to quit from Automotive Industry. However, Turkish auto industry had followed good strategies by taking some models, that are capable of selling in high volumes, from the main branches. This gave industry a great chance to survive. This trend had started up with the production of Tempra in 1995 by benefiting from Customs Union until the year of 2000. The design and production of Fiat Doblo and Ford Transit Connect had also enforced Turkish JVs on their efforts to survive. Not only design, but also joint-design and production of these models further developed the competence and capabilities of the industry by providing sustainable royalties for domestic industry. To some extent, this proposed a chance of participation for domestic JVs on decision-making processes of main branches.

To concretize the positive effects of R&D funding and sustaining JV projects, we find Interviewee 6's comments rewarding. From his experience, he stated that:

In TOFAŞ, Doblo was the ever first car that was fully designed and manufactured by a JV in Turkey. TUBITAK supports were effective in manufacturing the prototype. R&D department in TOFAŞ had been started up with 10-15 persons and then, it dramatically increased to 350-400 persons.

In accordance, Interviewee 8 also confirmed the positive outputs of R&D funding schemes and the well-timed and very-fitting decisions of Turkish JVs to survive:

> *Turkish-designed Doblo and Connect were the products of this period involving the understanding summarized above. Ford and TOFAŞ had given right decisions and they were to be more immune to the crisis in subsequent years.*

As Interviewee 6 stated, Ford Otosan is indebted its current R&D department with a personnel of nearly 1000 persons to the fitness of the decisions taken in that period on the production of Connect in Turkey. All of these comments support the findings of Özçelik and Taymaz (2008), describing the positive effects of R&D subsidization in Turkey.

In addition to the JVs, it is important to mention how the Turkish suppliers reacted to the changes of 80s and 90s. Interviewee 3 outlined this as given:

> *Between 1995 and 2005, in addition to main industry, supplier industry in Turkey has made mergers and acquisitions with foreign partners. This has also impeded Turkey's presence on decision-making processes of global automotive industry. R&D efforts have been seriously lowered its speed since both JVs and supplier industry has been based on foreign partners. Domestic firms left are operating solely on defence and bus industries. This situation has inevitably made Turkey dependent upon foreign decision makers. Catching up has become desperate.*

Taking this quote into account, one can deduce that JVs and supplier industry in Turkey had managed to survive in export-oriented open market policy regime by merging with foreigners or performing projects based on the decision of main branches. This provided them, to some extent, to survive in fierce global competition; however, their independence on decision-making became decreased. On behalf of JVs, R&D capabilities seemed to increase while, for suppliers, theirs decreased to a certain extent.

Interviewee 5 briefly pointed out the results of this finding as:

> *If you are highly dependent on JV structure, it is not allowed to make your own R&D. Your innovations remain at firm-level or at best national level. Temsa, Otokar, Karsan and BMC are the only Turkish manufacturers having their domestic products.*

We strongly assert that this finding is able to explain why we have found a stagnation of R&D sophistication in Turkey in Chapter 4 using TTGV data. To continue, we should also state the findings for subsequent years after 2005. For the supplier side, Interviewee 3 claimed that:

> *By 2010, the trend outlined above has turned backwards. Some big suppliers in Turkey bought their foreign partners and then, became domestic again. In Turkey, the antecedents of global players would come from suppliers.*

About Turkish JVs, Interviewee 6 commented that:

> *In the years of 2008-2009, Turkish Industry experienced positive trends and the sophistication of projects and their potential moved upwards. However, after that year, there seems stagnation. Nowadays, one thing worth noticing is that Ford has taking charge of important developments in engine control units.*

These quotes suggests that, particularly for recent years, Turkish suppliers has participated more on decision-making by capturing foreign partners and JVs are carrying on capability building by taking projects from foreign affiliates and performing them as Atağan (2011) argued for sample of firms in Bursa. Nevertheless, we are not certain that it signs a certain breakthrough for the case of dependence on foreigners. Interviewee 14 supported this view by emphasizing "only 40 percent of Turkish suppliers are capable of establishing strong connections with global OEMs. In the future, this trend seems to be immensified but there is much to do in this way".

Another question to pose is how the R&D funding schemes affected the capability building of Turkish JVs and suppliers during that period? What were the purpose of them and were their goals attained? What were their outputs? In which aims did they fall behind? To answer these questions, we argue that Interviewee 8 who held key roles in design and implementation of subsidization programmes, proposed invaluable insights. She stated for the very beginning period of supports as given:

> *As we started to support R&D projects during 1990s, Turkey was lack of design and design confirmation processes. In that case it is not expected to give R&D support due to incapability of industry on performing real R&D. Thus, we had*

> *taken into account the real needs of Turkish Industry, establishing R&D support schemes towards new product development. During this very first period, we had supported the projects by concerning the fact that capability building should have been achieved and JV should have reached to the desired position to take the design intensive part of automobile manufacturing provided by the main branch. In this support schema, responsibles in public institutions should also have been specialized in the sector, having know-how for design process.*

Given this quote, one might conclude that the first aim was providing capability building at the very beginning. TIDEB subsidized the projects towards increasing the awareness for R&D and innovation by supporting even firm-based innovations. Interviewee 11, who was well-knownto have the experience of R&D supporting programme in TTGV, confirmed this view by stating the non-existence of R&D performers in industry because of the lack of R&D culture in the nation.

These supports towards capability building seem effective in enhancing Turkish Automotive Industry because, as mentioned above, we see some projects performed and the achievements on them certainly provided the survival of both suppliers and JVs in the period in which the industry was once opened global competition by removing tariffs. Moreover, these subsidies brought up the dissemination of project culture by performing R&D projects. Interviewee 8 prescribed how they co-jointly achieve this success with other subsidization institutions, particularly during 90s, as follows:

> *In 90s, TTGV and TUBITAK had given their decisions about R&D supports by recognizing each other and there left no room for contradiction in decisions for the same project. The provided money was firstly approved by Ministry of Foreign Trade. In succeeding years, KOSGEB joined this occasion and approved projects that had been pre-approved by TUBITAK. TUBITAK had reasoned every decision – positive or negative concerning the applicant projects. In fact, this was transparency and control mechanism. These institutions had operated co-ordinately in 90s. R&D system in Turkey should be self-learning system; and this was a good example of such kind of support systems.*

Despite these successes at the beginning, Interviewee 8 did not hesitate to criticise the support system of Industrial R&D in the subsequent years by emphasizing that:

> *I certainly claim that after the subsidization institutions had lost their cooperative work; the point of view changed and R&D supports has not been institutionalized. In Turkey, R&D policies have focused on giving money. It has given the money as well! But, since there is no policy base, it has become obsolete and unsuccessful. The birth, appearance, flourish or emergence – whatever you want to say, do not mean that it contains the whole system. Of course, there are so many good examples of R&D and innovation projects; however, it cannot be generalised for the whole system and we cannot say that Turkish Industry has become more innovative.*

Interviewee 8 also stated her recommendations for the future as:

> *A good policy maker should foresee the future. This is why you need to make foresight studies methodologically and periodically. You should learn how to catch and use dominant technologies. Indeed, the most important are such technologies. Technology is a cumulative process which inherits the leapfrogging effect inside. It requires permanence. While giving R&D supports, it is necessary to infiltrate the support that have potential to develop technology.*

According to these views, we can assert that Turkish R&D funding schemes are especially useful in capability building in performing projects and creating awareness about R&D and innovation. Despite their limits, they helped automotive industry particularly in a period of competition that had been newly opened to global challenges. But, there seems a lot to do in supporting Automotive Industry since there is a still much to do in performing global excellence in certain areas of technological specialization. Providing complementarity, coordination and coherence in different agents of support systems seems crucial to achieve this.

To finalize this section, we lastly review general opinions of our interviewees about the historical period concerned here. Interviewees generally agree that, in auto industry, Turkey has reached a certain excellence in quality and manufacturing. For example, Interviewee 3 confirmed this by the given quote: “With her 50 years of

experience, Turkey has learnt how to produce efficiently in a good quality and how to implement production methods and produce a ready-made product".

Interviewee 7 also approved this view as follows:

> *Since 1960s, it has been recorded a considerable development in auto industry. Reaching a certain level of intellectual capital has been an accumulated process during this 50 year period of time. Turkey has reached this level by manufacturing. Now, manufacturing has reached a certain kind of maturation. On tier 2 (supplier industry), quality, planning and lean manufacturing has become well-developed. Before 2000, no one was able to expect this kind of development.*

Given these quotes and other parallel arguments of Güleş et al. (1997), Samsunlu (2007) in Chapter 2, one can deduce that Turkey has reached a certain level of excellence in manufacturing but this does not guarantee that R&D sophistication of Turkey has reached a critical threshold to maintain catching up and leapfrogging. It is realized some bottlenecks both in industrial development and R&D funding schemes. In addition, there are also pessimistic views on the general outlook of Turkish Industry. Interviewee 5 claimed that:

> *In the past decade, Turkey seems to become "industriless". For manufacturing, Turkey was at 13th place at the beginning of 1990s; however, now it is at the 17th position despite its export success in certain fields. In ruling government, there is no politician from industrial origin. And the worst thing is unless you have any industry, the money is not being left within the country borders.*

To conclude this section, we are asserting that:

***Assertion 4*: Import substitution policies ignited the learning process of assembly production in car manufacturingeven though it caused some bottlenecks mainly dueto the lack of competitive culture.**

***Assertion 5*: R&D subsidization schemes in 90s helped the industry to survive in the global markets by enhancing excellence in manufacturing cars and car parts and to a certain extentin developing R&D projects**

***Assertion 6*: Despite increased awareness and successful performance in R&D project development, there is very little evidence that supports the argument that Turkey is initiating more sophisticated R&D projects over the years. One cannot talk about a catching up effect in this sense.**

6.3.3. Findings for Current Turkish Automotive Industry

As mentioned earlier, Turkey has currently attained to be a manufacturing base for global auto producers. Certain level of capability for quality and productivity in manufacturing has been accumulated. The general situation of the industry was stated by Interviewee 1 as:

> *Currently, Turkey is earning money from efficiency. This efficiency is sustained by improved labour capabilities, production time, production cost and logistics cost (such as by implementing Just-in-Time (JIT)).*

Surely, the current situation based on manufacturing efficiency is not sufficient for the industry to increase its position in global value-chain. Interviewee 3 opened up this discussion as quoted:

> *Turkey is coming from at the end of the value chain. And in current position, Turkey has just arrived the phase of R&D. There is a huge gap between basic research and R&D; and Turkey is now trying to narrow this gap by her experiences of production and industry. In Turkey, there is a bottleneck that Turkish firms are only trying to survive. They are performing R&D for surviving. And for R&D, Turkish Innovation System is incapable of supporting competitive projects. Turkish firms are investing on projects involving lower risks. This bottleneck should be overcome by supporting competition and risky projects.*

This quote explains some important bottlenecks in the Turkish Auto Industry. Firstly, firms are not creating value-added by only having excellence in production. New R&D projects have lower risks and they are more incremental, not providing high profit margins. Performed projects are not at the state-of-the-art level since they they don't take their sources from basic research and development.

Interviewee 3 prescribed the nation's low capabilities on basic research and development as follows:

> *One of the weakest sides of Turkish Innovation System is the supports for experimental R&D. This side should be supported by further programmes without neglecting positive externalities in a long period of time. Turkey also seems weak in basic research. In contrast, newly developed countries such as Taiwan are highly specialized in generic and advanced contemporary technologies such as nanotechnology and in basic science such as physics.*

In addition to this, Interviewee 8 explained why Turkish industry is not capable of high profit margins as:

> *Technology level is also important in car manufacturing process. Turkey is highly capable of mass manufacturing in automobile. But this is the least profitable part. Aftermarket services are of vital importance in increasing profits. As known and frequently announced by the government, our export performance is increasing in automotive industry. However, it does not worth much because we are manufacturing cars without absorbing R&D and developing technology. So, we are not succeeding in catching up and leapfrogging.*

From this quote, one can deduce that Turkey has focused on the least profitable part and is not capable of upgrading this level because of the shortcomings of experimental and basic research mentioned in preceding quote. Here, another issue to discuss is on which parts of the automobile Turkey's capability has been built.As Interviewee 8 stated, today, the most important issue is the field in which a nation have deeper capabilities and is specialized. The problems encountered should be treated smartly. At this point, the question is whether Turkey is capable of solving the problems in this way. Interviewees are not optimistic about this in general. As for the areas Turkey has specialized in, Interviewee 5 commented that Turkey is capable of designing a whole vehicle; on the other hand, it does not succeed in designing components. Generally, engines, transmission components and axes are being imported from the global producers. Turkey is focusing on body, body equipments, seats, interior trims and plastics parts. Even in those areas of

focus, Turkey is not producing from scratch. Interviewee 5 finally argued that this situation also explains why domestic industry is not collaborating with universities effectively.

In addition, Interviewee 1 asserted that:

> *We have no manufacturers in automatic transmissions, engines, vehicle control units, software integrating with mechanic parts, brake systems. Furthermore, Turkey has no manufacturer producing boards and cards that are being used in automotive software. Unless you are uniting mechanics with software, it is hard to have more value-added. For foreign firms, they sustain higher value-added by combining mechanics with software.*

As mentioned in preceding section, this quote is also establishing the significance of electronics in automotive industry to create value-added and proved that Turkey is specialized in projects involving lower R&D sophistication as argued in Chapter 5. Turkey is, moreover, incapable of designing systems. Interviewee 8 commented on this as:

> *We are lacking in design, design confirmation. We cannot develop concepts maybe because of the reason highly dependent structure on Joint Ventures. We are not even developing engine, power transmission. We are not at that point.*

Interviewee 3 deepened this discussion, explaining how JVs are impeding designing processes as given below:

> *Turkey should pass into the phase of concept design rather than product design. For example, domestic industry should need to investigate how to design and produce 600 kg car rather than 900 kg ready-design. This might happen by having own brand. JVs are not trying to pose such kind of questions since their interest are limited to the mission given by main branches. So, further needs might only be triggered by having own national brand. The domestic connection between markets and R&D is getting lost because of this structure. We do not need to develop car by taking the signals of the markets. JVs do not need it or main branch do it instead of JVs operating in Turkey. Furthermore, R&D and markets relationship is not being supported in Turkish Innovation System.*

Here, we understand that transition into designing phase requires concept design that is triggered by perceiving market needs.[91] Rather than realizing market analysis, Turkish manufacturers are taking signals from JVs or main branch to produce parts that are highly related to the models established by main branch. This is an important finding to discuss how to overcome such conflicts. And as Interviewee 6 and 8 added, not only JVs, but also suppliers are not the ones that are capable of developing designs. Interviewee 8 described the effects of this dependence on national industry as:

> *The high dependent structure on JVs and subjection to MNEs make us stay in the second league, in the periphery. It helps in relieving the industry and demotivates to further develop the industrial structure. Staying at the low profit manufacturing is riskless. But if you do not improve your capabilities, it is possible to lose the main branch for a JV. Turkey should have made the decision about JVs before 1980.*

In accordance, Interviewee 6 asserted the result of this dependence as given: "Turkish Industry is completely depended upon main branches of MNEs. We are producing products that MNEs want and we are selling the products to markets that MNEs wish". On supplier side, Interviewee 14 emphasized the same by stating that "even being on the phase of co-designer, Turkish suppliers take market signals with the provision of OEMs and MNEs. They are not 'on the market' for performing R&D with design-intensive phases".

These quotes explain that Turkish Industry is limited by the willingness of main branches of MNEs, impeding the endeavour of national industry to execute the projects with high-value added by taking higher risks. This emerges as a serious problem for improving the capabilities of domestic industry involving both JVs and suppliers.

[91] It is also discussed in Chapter 2 by referring Lee and Lim's (2001) model of technological development which argues market success should be accompanied with technology adoption. Please also see the discussion of L. Kim's (1997) concept creation as the last phase of technological development.

Whether JV-based structure is not capable of improving R&D and design, is there any case that we might exemplify, having national brands would advance those processes. Interviewee 7 made this comparison:

> *For about long years, the national success in bus manufacturing has been expressed. Otokar has a wide array of product spectrum. By incentives, employment and R&D, Turkish Auto Industry has reached the level of sophisticated products on manufacturing. National brands like Otokar are producing tanks. JVs such as TOFAŞ and Ford are not willing to make this kind of projects because their main branch is not taking charge of them for these national projects. Turkey had mistaken by not founding its national brand. Without having specific brand, we could not have held certain kind of strategic elements that are required to develop industry.*

Given this quote, one can assert that national brands create more space to move on to R&D by observing market signals and then, reacting to them consciously. However, this argument should be further improved.

The general argument concerning technology transfer is about the convergence between developed countries and the latecomers. International projects are able to attain this mission. Here, the question is whether they are functioning in this manner. Interviewee 9 commented about both international and national R&D projects performed in Turkish Industry:

> *International projects are helping firms survive in current industrial position. In Turkey, the speed of creating knowledge is slower than the developed countries. International projects are helping in not to widen this gap much more dramatically. National R&D is not sufficient to create more knowledge and to narrow down this gap. For example, Fiat Research Centre had not given permission to TOFAŞ for R&D. After 2003, with the help of European Framework Programmes, TOFAŞ and Fiat R&D departments have begun to collaborate. For TEYDEB projects within automotive industry, they are focusing upon efficiency sustained through process innovation. Product innovations are rare.*

This comment confirmed that there is no catching up effect of performed R&D in the Turkish Automotive Industry. They are only useful in not to diverge from the

forerunners. Moreover, they are intensified in the field of process innovation, validating the efficiency-oriented structure of Turkish Automotive Industry outlined by Chapter 4.

Up to now in this section, we have discussed how JV based structures have limited the further development of national industry, but this does not mean that JVs have not contributed at all. In contrast, JVs have functioned so as to develop Turkish Auto Industry. This is not a contradictory view. We can describe this argument by quoting Interviewee 3 as given below:

> *JVs are not keen on creating national brand. But this does not mean that JVs has not helped to improve national industry. Without the participation of JVs, we would have been incapable of developing our national industry. It is a fact that Turkey should have started up its national brand as it was a closed economy and had chance to implement import substitution policies to overcome the global competition by protecting its infant brand. But in that time, there had been some serious problems about the presence of market, capital and intellectual capital in Turkey.*

The topic related to JV-based structure, as discussed in preceding sections as well, is about owning a national brand. In this case, it might be argued that more sophisticated projects involving design intensive character based on market signals mighthave been developed. In the preceding section, we have explained in a historical perspective why Turkey has not attained to establish its own brand. However, it is also a hot-topic for about 3 or 4 years in Turkey. The ruling government dictated an initiative to perform such kind of venture. For today, our interviewees are not optimistic about having a national brand due to the changing conditions in the global industry.

Firstly, Interviewee 8 asserted the main frame surrounding today's political sphere as:

> *It is impossible nowadays to implement policy measures as same as 1960s. Today, policy measures should take into account two phenomena: consolidation and globalization. It is impossible to implement policies against them. But in 1960s, there was much space to implement other kind of policies such as*

protective or interventionist measures; Turkey has lost an important opportunity.

Interviewee 6 also argued that it was much easier in the past:

In terms of national brand, currently it is hard to have it on free market basis. Government should perceive this as an investment for future because having a trademark in automotive industry proposes many benefits for the national industry. In 90s, it could have been in a much more ease to have a national brand especially before having submitted to Customs Union Agreement.

In view of this quote, we can conclude that given the open market policies implemented and the conditions of globalization and consolidation emerged in the industry, it is hard to venture for a national brand. Political and economical spheres are strongly constrained.

While criticizing the way of initiative, Interviewee 3 also explained the rationale why government was taking the initiative to make such kind of venture to develop national industry:

For a national brand, government authority is right but its quest does not seem true and feasible. In the scope of 2023 Vision, to attain the goals, Turkey is obliged to produce more than 4 million cars a year. In Turkey, cars are manufactured by JVs up to 90 percent. And on behalf of JVs, it seems harsh to attain this goal. Thus, there are two possibilities: the first one is to increase JVs number and their production; the second option is to make own brand and produce under that name. Thus, domestic car brand seems as not only as "national pride" but also as economical necessity for achieving the national objectives. However, for the proposed model of market entry for national Turkish car seems as completely false and mistaken. For example, in sedan segment, there are 48 models present in the market. Turkish car should be driven by a need that is still uncompensated in the market. For example, Renault Kangoo was driven by EU measures about SMEs and it had created a market of 1 million cars a year.

Other interviewees did not see any possibility on having a national brand. For instance, Interviewee 9 argued the same as Interviewee 3 by stating the fact that a national brand does not seem possible and feasible from scratch. For the emerging

technologies such as electrical vehicles, there are areas of certainties to be dwelled upon such as range, engine technologies, consumer trends, competitive pressures by newcomers. The high risks inherent to emerging technologies could possibly be compensated by public procurement policies.

In accordance, Interviewee 7 outlined the possible competitive pressures on a new brand by emphasizing the significance of convenient business model:

> *For establishing national brand, if Mercedes is producing cars cheaper than Turkish counterparts, Turkey has no chance to compete. Cultural factors would also influence the efforts and it is hard for national brand to sell cars even in Turkey. For national brand, the main issue is not "making the car" by establishing a good business model that helps permanently survive the new brand. In the OSD report,[92] for a feasible model, it should be sold over 200000 pieces a year. For 1 $ investment on manufacturing, you should also venturing 2 $ for marketing the car globally. Furthermore, one segment is not enough to make national brand survive. There should be upper and lower segments for each model to capture the interest of varieties of customers. This ecosystem should make itself circulate as a business. Under these conditions, having national brand is a political measure that should be treated as 'national necessity'. By only treating like this, this aim might be achieved.*

Interviewee 5 called the initiative of establishing a new brand as a "late enthusiasm" by mentioning the significance of launching a product portfolio rather than a single car to achieve a successful initiative. In Interviewee 5's opinions, today's automotive industry requires to introduce new alternatives to customers both in upper and lower segments. So, it makes further difficult to establish a new brand.

We consider that above comments are providing invaluable insights for venturing a national brand. At first, it is not likely to introduce this brand with a single model. It would also decrease the chance of its commercialization, notwithstanding other parameters. Furthermore, current brands have so much reputation making it impossible to compete with them. The well-organized scheme of the industry is bringing up the marketing costs higher. Even the strategy to sell the new brand to

[92] This report was prepared by OSD upon the discussion of owing a national brand and was not publicized due to confidential reasons.

domestic market or closed markets is not reasonable and it is not certain that it would reach the sufficient economies of scale since the concerning markets are open to free competition as well.

Hence, under these current situations, what should Turkey measure for future policies? How could the country possiblysolve its problems about dependency on JVs and having a national brand? What should be the future perspectives and strategy? Interviewees, moreover, commented on these issues. Their opinions are given below.

Interviewee 1 gave invaluable insights about the requisites of investment on Turkish Automotive Industry. He drew the general frame of investment as follows:

> *Raw material investments require scale, investment (amortization) and logistics. For Turkey, there should be an investment whose raw material investment is none, first investment is low, logistics investment low and competitors are well below the average. Design, engineering and software firms in automotive industry look like within these limitations.*

As Interviewee 1 pointed out the suitable climate to invest on design and engineering projects, Interviewee 8 asserted the current condition of Turkey and added that as given:

> *Does Turkey have a firm similar to Ricardo in England that is leader in engineering intensive services for automotive industry? Maybe, Figes and Hexagon, the most reputative ones in Turkey, might be the 'little' examples of this question. Turkish domestic firms are only using and implementing manufacturing technologies. As a firm, only if you are capable of developing technology and specialized in some part of it, you can play a global game.*

Given these quotes, one can deduce that manufacturing based automotive firms in Turkey should be empowered by design and engineering firms. This is also concurrent with our findings of Chapter 5. It may help them to increase their value-added and get them participated in MNEs' high value-added projects.In order to get involved in such joint projects with OEMs, Interviewee 1 offered to persuade OEMs to take R&D projects involving mechanics and software interaction. This

interviewee gave Fiat Common-Rail Project as a good example in this sense. He saw pre-competition collaboration as a good way to establish this kind of projects. This quote also noticed the importance of getting involved in projects that is integrating mechanics with electronics. Turkey has not managed to do so, given some successful examples as exceptions. As Chapter 5 depicted Turkish firms are not keen on participating collaborative and pre-competitive projects. The culture towards collaboration with both domestic and foreign partners is not common.

Under these conditions, our interviewees offered some future policies to implement in Turkey. But besides policies, we would like to draw attention to a striking point about investment climate in Turkey, which was commented by Interviewee 7. This interviewee emphasized the fact that, in Turkey, investment for R&D has gone to other fields of economic rent such as construction sector, putting this as an important restriction for the investment on R&D activities. It is surely valid for not solely automotive but also for the each type of productive industries as a whole. We found this a very precious argument explaining why performing R&D is not preferable for an investor. If there were open spaces to be invested with more returns with less effort, the rationale of capitalism would surely offer to invest those areas of preference. We strongly assert the restoration of investment climate towards R&D and innovation focus rather than rent economics.

To turn into topic, Interviewee 1 emphasized to measure long-run policies in contrast to political interests. In interviewee's point of view, the focal point should be R&D by appointing policies in a future period of 20 years and plus. Incentives should be designated in this sense by forecasting their multiplier effects. According to Interviewee 1, today's subsidization schemes are focused on product development rather than R&D.

Interviewee 3 expanded the discussion with the comment given below:

> *Turkish Industry should need to open a space for itself. Market needs should be determined and the industry should ask itself what makes them differ from competitors and other players. Every innovation should be driven by necessity*

> *in the market (for example: alternative fuel). The cycle should be as follows: understand the market => develop the product => market it.*

This quote also noted a prerequisite for concept design and confirmation. Due to depended JV structure, our industry is not affiliated with this paradigm of pursuing market signals.

Interviewee 7, moreover, asserted to have national objectives to go in the direction of one goal by stating that:

> *For development, it is a prerequisite to have national objectives to achieve. Even if half of it is attained, it would be a success. Technology intensive objectives are better for the industry. Turkey is not capable of realizing niche innovations. It might be sited for the places left by big players. The main question to answer is where we should go in current industrial structure. In order to protect current position, the industry should aim for the future.*

It reminds us the discussion of Ergas' (1997) about 'mission-oriented' countries. We find it as an invaluable clue for underpinning technology policy with a target. Interviewee 3 complemented this by asserting that Turkish IS should support technology push models to improve its capability of innovation. While attaining national objectives, it is desirable to push technologies to be used in national industry.[93] This makes increase the industrial capability of of nation on innovation by introducing more efficient way of doing things with performing R&D. Interviewee 9 focused on the selection of areas in which the national industry should aim to be specialized:

> *It is a concern of political authority and sectoral partners to collect the information concerning that in which part of the car manufacturing industry we will prefer to be specialized. Turkish Industry requires suppliers as strong as OEMs and consulting firms specialized particularly in automotive technologies.*

It is political authorities' mission to determine those areas of specialization by the wide participation, collaboration and consensus of actors in the industry. For

[93] For this aim, the policy tools in the framework of innovation systems approach are introduced in section 2.3.2.3 of Chapter 2. Signalling strategies seems as beneficial for such kind of technology push models.

instance, Interviewee 6 gave an example of further specialization as an area to be improved as:

> *In Turkey, for current position, specialization in seats might be furthered by being a centre of excellence in seats both in design and production. Such as this, suspension might be another branch of excellence.*

Similar areas should be determined by policy-makers to be improved to have a global excellence and more value-added.

On the issue of a national brand, our interviewees also put forward some suggestions and arguments. The general tendency is to have a national brand in emerging technologies with a spectrum of models covering new needs of customers that have notyet beenmet by the global markets.

Interviewee 6 claimed that a consortium might be set up to venture for a national brand, decisively emphasizing the need for taking this initiative.

> *For venturing a national brand, it might require to establish a consortium by several institutions such as İTO, TAYSAD and it might be even invested by foreigners up to 100 percent. Despite the fact that it has great amount of risky investment to establish national automobile brand, it should be done!*

In addition, Interviewee 5 outlined which areas of auto segment are empty, recommending those segments as a blank to be filled by the national initiative.

> *Recently for Turkey, there are two possible segments: off-road vehicle and performance cars. But in performance car segment, there is the presence of strong competitors like Ferrari, Porsche, Lamborghini etc., seeming not reasonable. For Turkey, vehicles using for distribution of goods in cities might also offer a potential. An electric vehicle used for this purpose might offer a new segment in Turkey and this potential producer might be supported by public procurement measures.*

Here, Interviewee 7 gave another good example of compensating the needs of the market by Turkish branding initiatives such as Karsan's New York taxi. He also pointed out that the point is not about invention:

> *For taxi tender in New York, even 1 % in this market is too important for national development of industry. But, having a multifunctional taxi is impossible to be invented by us. Surely, global players have not been willing to participate on this market because they are trying to concentrate on their core businesses. Public procurement and support might be good measures to be managed similar to the defense industry.*

This is a good quote emphasizing the compensation of market needs without inventing anything; instead, with focusing on the niche market that is left by other players. It seems as a good strategy for launching a national brand.

By combining this issue with the targets initiated by the ruling government, Interviewee 7 further commented on the issue as following:

> *Maybe it is better to attract one or more automotive brand. However, by improving GDP and wage per employee, Turkey has become to lose its feature of being manufacturing base. The highest value-added might be attained by know-how; then, Turkey should integrate global R&D centers with local engineering partners. This strategy is of vital importance rather than having own brand. The role Turkey will play in global value-chain is far more important. For example, in England, there is nearly no operation in manufacturing. The main strategy should be about fostering R&D projects. Incentives should be provided for MNEs which are establishing R&D centers in Turkey. Turkey should be knowledge producer and R&D creator. Ford Otosan has taken the diesel engine development activities from main branch. Such as this, Turkey should internalize R&D activities within her borders.*

This comment also pointed out the threat about the current situation of Turkey. The increase of wages – as an expected outcome with increasing wealth, is able to trigger the lost of competence in the industry. The only way to solve out the problem is to increase R&D capabilities of the country. Further targets might be attained by the introduction of new plants of new global brands with the channel of foreign direct investment. Current structure – even by increasing capacity – is not likely to attain the targets.

To conclude this section, we are offering the assertions below, explaining current situation in Turkish Automotive Industry:

***Assertion 7*: The impact of JVs on the technological development of the Turkish automative industry is inverted-U shaped. JV-based structure of the Turkish automotiveindustry has developed the national industry to a certain extent based on the excellence of manufacturing. However, this structure currently impedes technological knowledge production.**

***Assertion 8*: Having an own brand as a supplier, OEM or global automotive manufacturer, provides significant benefits for national automotive industries in terms of R&D and innovation. Design processes independent from foreign affiliatesare more plausible to involve concept design phases by receiving market signals which are helpful in creating value-added by building more sophisticated capabilities and projects.**

***Assertion 9*: For Turkey, it seems better to create a brand in the niche markets both as a main vehicle manufacturer and supplier in appropriate areas of specialization. However, the government should keep theright balance because such a pro-active policy initiative should not discourage the MNEs that are expected to invest in Turkey.**

6.3.4. Comparison of Turkish Automotive Industry with other countries

Before concluding this chapter, in this section, we are willing to outline the opinions of the interviewees about the relative position of Turkey. As shown in Chapter 4, there is a group of countries such as USA, Japan and Germany leading the industry. Also, there is one country, namely South Korea, which has managed to catch up with the forerunners. There are also emerging countries such as BRIC (Brazil, Russia, India, China),whichhave a potential to perform in catching up with the others inthe subsequent years. As a manufacturing base ranked in 16 in global auto production, Turkey is positioned behind these countries. Interviewee 8 supported this view as follows:

> *Turkey is far behind the countries with which is at the same position at the beginning of 2000s. BRIC countries seem as paced faster in automotive industry. The main reason behind this is about the policies measured. Public*

> *policies are like back of a knife and Turkey has not managed to do the right choice.*

In accordance, Interviewee 9 explained why Turkey has not reached even the level of BRIC countries:

> *Turkish Auto Industry has begun to perform R&D so lately. We have not been able to be competitive for this reason. And currently, we have just been so late to produce our national brand. Currently, it is impossible to catch up forerunners. Turkish Industry is developing but while we are taking 5 steps, forerunners are taking 10 steps. Furthermore, global players will not be willing to have another competitor in the market. For example, as a barrier, Europeans is asserting too many regulations to block their markets for Chinese brands.*

This quote successfully describes why Turkey has failed. It is also a path-dependent process involving many other determinants. It is perceived that the well-organized scheme established in the industry is not open to newcomers. Entry/exit barriers are high. Here, we can consider how some countries succeed in showing better performance in comparison to followers. For instance, for China, Interviewee 8 proposed the comment below which is in parallel with the arguments of Wang and Kimble (2013):

> *For periphery countries and their firms, they have one opportunity - affecting decision makers and global manufacturers with their technological capabilities. They manage to be global only if they can influence the global decision-makers. And even if nation states are still effective politically, multinational enterprises make their own decisions usually by neglecting other decision-makers. The main difference of China is to intervene perfectly to the markets by giving several kinds of subsidies to their domestic firms. They are even interventionist in competitive and pre-competitive regulations.*

In addition to China, Interviewee 7 commented on another successful example succeeding in catching up and leapfrogging by mentioning South Korea. It is concurrent with the arguments of L. Kim (1997). Interviewee put South Korea's difference with Turkey as:

> *Kia and Hyundai are good examples to show how national brands might possibly change the industrial path through development. With JV dominated structure, we have left stable in direction of path which are drawn by main branches in accordance with their global strategies.*

For Turkish brands, the same interviewee asserted that:

> *Otokar, TEMSA, and BMC are all unique domestic brands. They have managed to survive without trusting on 'big brother'. However, their production volumes and revenues are not sufficient to direct the national industry. In some JVs, there is a department of R&D with only 400 employees while in Otokar, there are totally 2000 employees in R&D. We need longer time, longer investment and more R&D employees to catch up the leaders. However, it is not possible since the market for these domestic brands has only reached to 4000-5000 units per year.*

Given the quotes above, we consider that branding is a useful tool to participate in global decision-making process. Turkish policy measures have not been directed towards this goal until now. Turkish brands are not effective due to limited sizes they have. Interventionist and protective measures are prominent as a country establishes its national brand.

However, Interviewee 9 widened the discussion, proposing the view that measures to take are not limited only to branding:

> *Each country is not obliged to produce final product in global value chain. Having strong suppliers is also an eminent issue to consider. Some countries such as Israel and Switzerland are in value-added part of the value chain with the presence of their suppliers. In contemporary automobiles, each component is another area of expertise. We need to accelerate the speed of reaching the knowledge. For example, for this aim, South Korea is a associate member of EUREKA programme. Turkey should represent itself much more in knowledge-intensive networks.*

On behalf of Turkey, one can deduce that she is much behind the forerunners both in venturing a national brand and in specializing in an area of expertise. Finally, Interviewee 7 claimed for the general position as: "Turkey seems at *Second*

*Division*in automotive industry in terms of revenues and unit production. Countries in the *First Division* have geographical and demographic advantages".

To finalize this section, we can assert that:

***Assertion 10*: Turkey is behind the forerunners of the automotive industry and the opportunities for catching up and leapfrogging are very slim; in contrast, it can even be argued that the gap between forerunners is extended.**

6.4. Conclusion

In this chapter, we have outlined our findings from the interviews held by important industrial experts and professionals in a semi-structured format. We have separated our findings into four groups introduced by sections and, for every group; we have made assertions about our current topic. Table 17 summarizes our findings including assertions and what they are saying about our main concern, technological sophistication.

The findings suggest that Turkey has reached a certain capability of expertise and excellence in manufacturing. The industry was ignited by import substitution policies and supported by R&D subsidization schemes when it was opened to global competition. This helpsit survive; however, the national industry still lacks certain capabilities such as concept design, performing sophisticated R&D to have royalties etc. due to its JV dominated structure. The initiative for establishing brand seems as 'late enthusiasm'. Turkish firms do not seem capable of participating global decision-making process of the well-organized automotive industry which further impedes its development.

The future policies should involve certain measures to constitute a national brand in a niche area of expertise, to be specialized in some technological fields of global industry, to have strong supplier presence by networking with domestic and global knowledge flows. Moreover, technology transfer and participating in global knowledge flows should be maintained by increasing foreign direct investment of global brands.

To conclude, expert interviews have given invaluable insights that support the findings of Chapter 4 such as dependence on JVs in design capabilities, no technological sophistication in terms of R&D projects and no robust sign for catching up in industry as a whole. This chapter also approves the findings of Chapter 5, stating considerable impediments of the industry both in micro and macro levels. Moreover, this chapter explicated that experts generally agreed upon the current condition of national industry, not holding a success towards more sophisticated R&D performance in comparison with its counterparts and thus, there seems no robust sign of catching up, as well. The views of experts about the issues discussed are summarized in Table 18.

Table 17 Assertions proposed by expert interviewees in selected areas of concern

Areas of concern	Assertions	What it says about technological sophistication?
Macro conditions and global trends surrounding Automotive Industry	Assertion 1, Assertion 2 and Assertion 3 on page 169.	The current global automotive industry is well set-up with high entry/exit barriers and technologically sophisticated projects are being held by forerunners. For latecomers, it is supposed to have technological sophistication by participating design intensive processes to have royalties provided by national JVs and suppliers by networking and integrating themselves with the global industry.
Policy measures in Turkish history towards Automotive Industry	Assertion 4, Assertion 5 and Assertion 6 on pages 177-178.	Import substitution policies of 60s and 70s; R&D subsidization period of 90s and 2000s were resulted by excellence in manufacturing and established culture in R&D operations in Turkish Auto Industry. But it does not mean that Turkey is succeeding in state-of-the art technologies. There seems no catching up the forerunners in this sense
Findings for Current Turkish Automotive Industry	Assertion 7, Assertion 8 and Assertion 9 on pages 191.	The JV-based structure of Turkish Industry was eminent in the constitution of manufacturing capabilities, but however, it also impedes the further development of the national industry with its inherent structure of dependency in decision-making and inhibited capabilities on concept design. To attain 2023 targets of export, Turkey should find out niche markets to establish its niche brand and should open the channels for foreign knowledge flows with foreign direct investment of global brands. This might help to introduce more sophisticated R&D in national industry.
Comparison of Turkish Automotive Industry with other countries	Assertion 10 on page 194.	Despite its export success recent years, Turkey's relative position to forerunners, leapfroggers and BRIC countries do not make sense and we cannot refer about catching up the forerunners.

Table 18 Expert opinions in brief

Interviewee No.	**Int. 1**	**Int. 2**	**Int. 3**	**Int. 4**	**Int. 5**	**Int. 6**	**Int. 7**	**Int. 8**	**Int. 9**	**Int. 10**	**Int. 11**	**Int. 12**	**Int. 13**
Position	University	NGO	Firm	JV	Consultant	University	Firm	Specialist	Firm	PPP	Specialist	Firm	Firm
Manufacturing Capabilities	●	●	●	●	●	●	●	●	●	●	●	●	●
R&D capabilities	o	●	o	o	o	o	o	o	o	o	o	o	●
OEM dependence	●	o	●	x	●	o	●	●	●	●	●	●	o
Technological Sophistication	x	o	o	o	x	o	o	x	x	x	x	x	o
Catching up	x	o	x	o	x	x	x	x	x	x	x	x	x
Owning a national brand	x	x	o	x	x	x	x	x	x	x	x	x	x

● : strong support o : support x: reject

CHAPTER 7

Findings and Policy Recommendations

7.1. Introduction

In this dissertation, we examined the technological sophistication level of the Turkish Automotive Industry by using a novel methodology including both quantitative and qualitative methods. We consider that this approach has overcome the limitations of both types of research by describing a unique methodology to question the evolution of R&D projects in a given industry. We have embarked upon the hypothesis that Turkey has subsidized similar kind of R&D projects, particularly intensifying on traditional technologies of the automotive sector. We have examined what the literature offers us about the terms, catching up and leapfrogging, which then have become the general framework of the study. We have described what we refer as technological sophistication within the framework of catching up and leapfrogging. We define technological sophistication as:

> *a state where* technologies depend on novel R&D projects that involve high value-added, that aim to attain high level of innovation within contemporary technologies of current automotive industry, and that are based upon design intensive products/processes without depending upon OEMs as customers or know-how providers.

Keeping this definition in mind, we have designated a quantitative and two qualitative studies in order to test our research question and related hypotheses. In thequantitative part of the thesis (Chapter 4), we have used TTGV data covering 86 subsidized projects in the automotive industry in the last two decades. The main finding is that although there was extensive learning in the Turkish Automotive Industry especially in the post 1990-era, Turkish automotive industry is not fully capable of taking the next challenge: catch-up with the world leaders in the automotive industry in terms of technologyand innovation. Then, we have initiated two qualitative case studies;first,with 13 firms all of which are subsidized by the TTGV (thus selected from the 86 projects in Chapter 4) and second, 14 high-status experts in the automotive industry by using a semi-structured interview format in Chapters 5 and 6, respectively. By holding firm visits, we have collected micro evidences while expert interviews have mainly offered us macro findings. Thus, the dissertation is based on detailed micro evidence carefully placed within a macro perspective.

To remember, the main research question of the study explained in Chapter 3 is:

By generating more sophisticated R&D and technological knowledge has the Turkish Automotive Industry produced more advanced manufactured products over the years? Is there a catching up or leapfrogging in this sense?

In the next section in this chapter, we briefly discuss the main findings of Chapters 4 to 6 and concentrate on the more concrete findings that may help to prescribe policy.We are confident that these results would suggest us the base for policy recommendations to provide a transition towards more sophisticated R&D in the Turkish Automotive Industry. In the subsequent section, by using them, we are to make policy recommendations by benefiting from different policy tools prescribed in Chapter 2. We finalize the thesis by narrating a general conclusion in the last section by proposing a brand new concept called “middle-technology trap”.

7.2. Discussion of the findings

In Chapter 4, we have analyzed TTGV data involving 86 applied projects in the context of TTGV's Technology Development Programme. In this subsidization scheme, firms had been subsidized with back payment. We have collected considerable data to evaluate projects by constituting several indicators. We have separated the subsidization period between 1991 and 2011 into meaningful time periods to measure the dynamics changing within this timeframe. The results are striking.

In brief, the findings of chapter 4 can be summarized as below:

- The innovation level of current R&D in Turkey stays at the national level, not showing signs of global impact.
- We have not taken considerable remarks for the national industry transforming into more contemporary technologies on R&D. The industry, in general, stays at the traditional technology level. R&D projects are mostly productivity oriented utilizing process innovation. Firms that do R&D focus more on survival rather than on growth.[94]
- The data gives us the fact that, in general, Turkish R&D aims at exporting to global markets. But, we are not able to express an opinion about the sophistication of markets or about the value-added it generates.
- From the data, we have observed there is strong presence of OEMs both as spec or knowledge provider and as a customer. In this sense, we expect that the national industry is dependent on the foreign countries in terms of R&D.[95]

Besides these remarks, the given data emphasizes the increased interest of firms on performing R&D. It also shows there is certain kind of learning process in the last 20 years. All in all, there has been extensive learning in the Turkish Automotive

[94] This result is in parallel with the findings of Ölmezoğulları (2011), Ulusoy (2003), Samsunlu (2007), Yılmaz et al. (2005), Pamukçu and Sönmez (2011) as outlined in section 2.4.of Chapter 2.

[95] This argument supports the arguments of Ölmezoğulları (2011) and Pamukçu and Sönmez (2011) who offers a low quality of interrelationship between local firms and foreign firms, involving low intensity of knowledge flow.

Industrybut it seems that this capability does not reflect in reaching a more sophisticated technology level. However, the data do not fully provided information on the sophistication of R&D projects. Thus, we considered that these findingsare required to be supported by firm-based evidences to understand the current (as well as past) learning and development process in Turkish firms. Also, macro-evidence about the sector is needed to illuminate the sustaining organization of the automotive industry to frame Turkish Automotive Industry in global competition. The TTGV data are not capable of giving concrete answers on whether Turkey has managed to step towards upper tiers of the global automotive industry by advancing technology and innovation. To clarify these blurred points, we initiated two case studies.

In Chapter 5, we have acquired several findings as micro evidence from 13 face-to-face semi-structured interviews held with subsidized firms. The interviewees were R&D managers or high-status managers of the firms. We have posed questions about their performed R&D projects by asking them R&D context, R&D output, firm strategy concerning innovation and finally, their opinions about R&D policies in Turkey. We have held interviews in the context of our prescribed term, technological sophistication by questioning several aspects of their R&D activities over the years. We have put forward several assertions by accumulating the views and information in the context of technological sophistication.

On behalf of the R&D context, we have determined performers has sophisticated their R&D activities to a limited extent since foreign-owned OEMs or JVs are the main decision-makers in the sector, providing less knowledge dissemination with respect to domestically-owned ones [96] Also, Turkish SMEs and suppliers predominantly intensify on traditional fields of technology, impeding their transition to more sophisticated R&D due to lock-in situation on their core businesses.[97] We argue thatdomestically-owned OEMs are more prone to develop domestic suppliers by widely disseminating and sharing their knowledge. For the R&D output, we reach similar results. We argue that firms having core businesses on contemporary

[96] Please see Pamukçu and Sönmez (2011) and Ekmekçi (2009) outlined in section 2.4.
[97] It also supports the arguments of Ölmezoğulları (2011) who describes Turkish position in automotive industry as in 'lock-in' situation.

technologies are more open to initiate sophisticated R&D. We have discussed the possible effects of OEMs on domestic firms; and as expectedly, global OEMs are found to be effective on commercialization decisions of domestic firms. It generates a certain kind of dependency on the appraisal of project outputs. Moreover, firm strategy towards innovation is another concern of us. We have determined that firms are more likely to gain new core specializations if they have core businesses involving contemporary technologies. This finding is capable of generating certain kind of opportunities for design and engineering firms. We have, in addition, argued Turkish firms are used to obtain specs from abroad rather than designing concepts on their own and this finding is more acute for supplier SMEs. Finally, the views of the firms about R&D policies on Turkey have been focusing on subsidization, emphasizing the need for new insights for industry about technology policy and innovation.

The findings of this chapter have offered some invaluable results as well:

- Turkish firms do not sophisticate their R&D activities; most of them are suppliers that have core businesses on traditional technologies. Domestically-ownedOEMs that outsource parts are more prone to sophisticate the R&D activities of their suppliers.
- Regardless of their sizes, Turkish firms in general are more or less dependent on global players on their decisions for commercialization. Firms performing R&D on contemporary technologies are more likely to sophisticate their R&D outputs.
- Firm strategies towards innovation implemented with the aim of specializing on emerging technologies are more likely to be operated in firms having core capabilities in contemporary technologies.
- Core capabilities on traditional technologies and dependence on OEMs seems to be the two most important factors that impede the sophistication of R&D in Turkey.

In Chapter 6, we have held interviews with several experts from different fields. They all have certain level of expertise on Turkish Automotive Industry. We have

posed several questions under the headings of global trends and macro conditions, policy measures in Turkish automotive industry, current findings and comparison of national industry with other countries. However, the main focus of the interviews was R&D sophistication of Turkish auto industry. The interviews were similarly realized face-to-face in a semi-structured format. There were 14 high status experts, drawing invaluable macro evidence for the study.

For the global trends and macro conditions surrounding automotive industry, our interviewees assert there is a well-organized industry with high entry/exit barriers (see Figure 10 in Chapter 6). The corners are captured and state-of-the-art technologies are performed by forerunners. As a latecomer like Turkey, the plausible way to increase its share on the global industry is to intensify on R&D in order to have royalties by performing design-intensive projects and by participating global networks to benefit from knowledge flows.[98]

In the interviews, we have also found precious comments to evaluate policies towards automotive industry. Interviewees claimed that import substitution policies of 60s and 70s, export-oriented policies of 80s and 90s and R&D subsidization policies of 2000s have generated an automotive industry in Turkey, having the capability of excellence on manufacturing and quality. However, a similar positive remark cannot be put forward about R&D. Over the years in the Turkish Automotive Industry, firms do not initiate sophisticated R&D projects. Turkey has fallen behind the forerunners in terms of world-frontier R&D and innovation without any robust sign of catching up.[99]

Findings for the current situation of the industry are not positive as well regarding the technological sophistication. Interviewees had a common opinion about JVs in Turkey; emphasizing that they have been so decisive in building up a national industry, but also, they have impeded further development of the sector especially in

[98]This argument offers to increase quality of knowledge flows from global OEMs to foreign affiliates by intensifying the knowledge dissemination. It is consistent with the findings of Pamukçu and Sönmez (2011).

[99]This outline of history is in parallel with the findings of Ölmezoğulları (2011) as outlined in section 2.4. It would be beneficial for us when we draw mid-tech trap figure of Turkish Auto Industry as an inverted-U shape in section 7.4.

terms of R&D. In their opinions, JVs are also responsible for inhibited capabilities of Turkish industry on designing concepts with their dependency on decision-making. They assert that Turkish industry should represent itself on niche products, preferably byto be established brands, by participating in global networks and attracting FDI to further develop the national industry.

Finally, interviewees assert Turkey has not managed to catch up in comparison with the forerunners, leapfroggers and even BRIC countries by its R&D performances. For example, Turkey has not managed to generate a national champion like Hyundai (Lee and Lim, 2001) as proposed by Section 2.2.4. The same section has also shown the efforts of China to generate disruptive innovations in the automotive industry (Wang and Kimble, 2013; Bower and Christensen, 1995); and we are not able to find out such kind of project initiatives throughout the Turkish Industry. We are confident that there are several efforts towards sophisticated projects in niche areas but they are not well-organized under a solid government policy when compared to the well established examples of Korea and China. In short, we summarize the findings of the expert interviews as below:

- The implemented policies until now have brought Turkey into a position involving a certain level of excellence on manufacturing quality. But it cannot be said on behalf of R&D.[100]
- The JV dependent structure of national industry impedes the national industry to some extent to sophisticate R&D processes and innovative outputs.
- When we compare it with other countries, Turkey has failed to catch up with the forerunners despite some good exceptional cases in the national industry such as design and production of Doblo and Connect by 2000s, the prototype of the New York Taxi project by Karsan, certain efforts of electrical vehicles performed currently in the domestic industry.

[100] This finding can also be associated with the findings of Ölmezoğulları (2011), Pamukçu and Sönmez (2011), Ekmekçi (2009), Ulusoy (2003) and the other several studies outlined in section 2.4.

After briefly discussing the main findings of the thesis, now we will try to phrase concreteresults upon which we can build policy conclusions.

Firstly, we begin with the current position of the Turkish automotive industry. Our findings suggest that Turkey has reached a certain level of excellence on manufacturing; however, one cannot tell the same for the context of R&D and the sophistication of the technology or the end-products. There are two important reasons that are related with each other regarding why Turkish Automotive Industry failed in sophistication in technology. Once we talk about global automotive industry, we mention about the one having high entry and exit barriers with corners held by forerunner countries in relation with their consolidated OEMs. Then, it is certainly difficult for the latecomers to take an advantageous position in such a scheme. It takes so much investment and it is also a path-dependent process based on the past capabilities of the nation. The other reason is the current structure of the national industry. Here, there are also impediments for Turkey. The first one of them is Turkish Automotive Industry is constituted by JVs not widely disseminating their know-how to Turkish suppliers because as a matter of fact the industry is more attached to the decision-makers of the global headquarters. As an important result of the study, we assert that the impact of JVs on Turkish Automotive Industry displays an inverted U-shape character.[101] The JV structure was essential in the learning process of Turkish Automotive Industry. They were highly effective in helping Turkish auto suppliers in terms of manufacturing and R&D capability building. But, on the contrary, post-2000 era the JV structure seems to impede further development of the Turkish Automotive Industry. This argument has been supported by expert interviews and firm visits in the study. We have noticed the restrictions, impeding its further technological sophistication, are being supported by this dependency of the Turkish Automotive industry on JVs and global OEMs. The other result is that Turkish suppliers are, in general, operating on traditional technologies (such as clutches, brakes without electronic components, seats etc.), sort of locked-in to these fields, making them unlikely to differentiate their core specializations towards contemporary fields (such as system design, composite technologies to alleviate

[101] This is one of the basic arguments of this study to assert mid-tech trap.

vehicle weight, electrical components that make the automotive and their safety systems more value-added etc.).

How to overcome these impediments on Turkish Automotive Industry is an important question to answer. Our findings put forward invaluable clues for this. We have determined that domestically-owned OEMs are more open to disseminate its know-how to domestic suppliers. Engineering and design intensive firms also have more tendency and capability to penetrate into more contemporary technologies and emerging fields. These are two important clues for us to offer. We assert thattechnology and engineering firms assisting global OEMs and domestic procurers have to be supported and their numbers should be increased. We also need domestic OEMs that are operating in niche areas by representing end products to the global markets. Turkey need 'national champions'[102] that are capable of participating in decision-making process of global automotive industry and, to some extent, directing the regulations legislated by the forerunners. These two assertions refer to a new policyperspective towards establishing those types of firms. The policies towards this end may involve specialized calls concerning automotive industry, joint projects with the participation of suppliers and JVs, local capability development with the participation of global OEMs in order to increase sophistication in R&D activities by disseminating knowledge and developing additional capabilities. However, what we propose is more than a new subsidization policy. It is more a new approach in policy where the government is more pro-active (see for instance Mazzucato, 2013). It is true that there are actually specific calls that aim to subsidize emerging fields of contemporary technologies in the automotive industry. But here, we propose to change the current scheme with a new one containing capability development of a selected firm. This scheme should be concerned with the capability development of the given firm towards being a national champion in the selected field by monitoring the advancement of the subsidized firm to attain this goal. There should be also measures to provoke holding a global end product manufacturer. We consider that the case of Hyundai (Lee and Lim, 2001) might be a good example of taking such an initiative. We are also confident that the increase in

[102]For this term, please see Rugman and Boyd (2003).

number of engineering and design firms in domestic automotive industry may help to sophisticate R&D by enlarging current design capabilities. This approach requires specific calls towards generating such kind of firms by encouraging entrepreneurship in this field of business.

Of course, the above suggestions do not mean current firms should be out of focus. For currently operating JVs, domestic firms and suppliers, we have also some suggestions. For domestic firms and suppliers on traditional technologies, we assert that their initiative towards being a co-designer should be supported. Being a co-designer rather than using ready specs provided would give them more opportunity to sophisticate their products and a certain negotiationpower with their outsourcers.[103] It would generate more value-added and profit for them. As expert interviews in Chapter 6 suggested, supplier industry in Turkey has reached a critical threshold. Here, we repeat our policy measure towards generating national champions by altering the current subsidization scheme. The supplier firms that might be capable of becoming a national champion by taking global initiative with its vision should be supported as well, with the provision of a brand new subsidization scheme. Co-designing capabilities and level of global expertise should be at the focus of monitoring placed in such a subsidization programme. For JVs in Turkey, we do not reject their contribution to current position of Turkey. JVs should engage themselves to global R&D projects of their headquarters by proving their certain level of R&D capability. In our studies, we have seen positive developments and success towards this end by taking the sign of their past initiatives such as their participation on design processes of Doblo and Transit projects. Having royalties for their R&D would furthermore offer them to increase their profits on the global industry. Their dependence on their headquarters would surely decrease as well. Subsidization schemes rather than current TUBITAK calls should be predominantly implemented for the Turkish JVs to monitor them as they gain royalties. Having royalties should be gradually awarded in such a subsidization scheme. We have found that the current scheme has nothing to do with the current JVs of Turkey

[103]Here, we refer co-designers having more central position in the value-chain of global OEMs by intensifying knowled flows as proposed by Pamukçu and Sönmez (2011).

because it barely focuses on eligibility criteria of R&D projects, notwithstanding their contribution to gain royalties. We are confident that having royalties novel designs such as new brake systems, new electronic systems or alleviation of body weights by using new composites and materials, enables our JVs differentating their position within the rankings of their headquarrters.

Secondly, micro-level findings offer that firms in contemporary technologies are more prone to advance their R&D performances. In addition, firms specialized in design and engineering are able to concentrate on contemporary technologies and niche products as well. These two findings make us offer the result that such two types of firms are vital elements to develop the industrial level of a domestic industry. The incentives for firms having core businesses in contemporary technologies, design and engineering should be designated in a new legislation of Incentive Law. As previously offered, we also see TUBITAK calls designated with a previously explained manner, as an indispensable element towards this aim in case of the alteration of current subsidization approach. Such kind of policy measures, we claim, is able to enhance the R&D outputs and their commercialization.

Atthe macro-level, we have asserted that Turkey has not succeeded yet in catching up forerunners in the automotive industry. The reasons behind this assertion has been based on the findings, emphasizing little sophistication of R&D context and outputs as well as the dependency of the national industry on global players in general. The sectoral innovation system of Turkish Automotive Industry requires smarter measures of policy-makers such as provision of disseminating knowledge by enhancing networking and global knowledge flows (EU programmes, joint research with the USA and Japan), fulfilling the non-existent parts of research infrastructure in the automotive industry (wind tunnels etc.), developing intellectual capacity of human infrastructure (increasing employees with PhD. degree, generating a suitable system for intermediate workers etc.), supplying complementary institutions and overcoming current lock-in problems regarding technical change predominantly seen in the Turkish supplier industry. R&D subsidization in Turkey reflects there is a certain success in attaining firms' awareness and performance towards R&D in a positive sense. However, it does not guarantee that this is a sustainable strategy for

catching up. One can argue that export numbers in this sense is a good indicator of a developing auto industry in a growing national economy; nevertheless, they do not tell us much about any transition towards sophistication. In fact, by just producing and selling traditional body parts and automobiles, one can increase exports. To overcome this situation and get into the direction of catching up requires more comprehensive policy measures to be implemented. More aggressive policies rather than subsidization might be measured by involving more detailed view of innovation regarding the systems of innovation approach. While referring "agressive" measures, we do not mean supply-side measures that have long been implemented as policy tools. In contrast, we propose, to some extent, demand-sided and protectionist measures in order to generate national champions that are capable of empowering national industry as a whole.[104]

To sum up, we have examined five main results in this dissertation. In brief, they are as follows:

- The global and domestic outlook of the automotive industry has not allowed domestic industry to reach a higher level of sophistication in terms of R&D activities. The dependence of domestic industry on global OEMs is a major impediment factor.
- Turkish Automotive Industry has gained the capability of basic design (generally given by global outsourcers) and manufacturing excellence by the prevailing industrial organization that depends on JVs and foreign affiliates.
- However, the evidences from Chapter 4, Chapter 5 and Chapter 6 depicts that the current level of excellence on manufacturing technologies are not sufficient to guarantee that national industry has managed to catch-up in terms of producing our own technology and innovative products.
- The dependence on JVs and foreign affiliates was capable of developing national industry to reach a certain level of manufacturing excellence;

[104]Please see our discussion of innovation systems approach in Chapter 2. As outlined, Freeman (1987) challenged Washington Consensus by asserting this new approach of those days. In addition, Lundvall (2004) put forward that developing countries require new policy measures in contrast to what neo-liberal arguments have imposed upon them.How could these measures be is given in the last part of this chapter with the provision of some examples.

however, it currently reflects as an impediment to acquire a transition from manufacturing phase to a design intensive phase. We assert that the effect of this dependent structure on the capability development of the national automotive industry as an inverted-U shape, restricting also the efforts towards catching up by advancing in design-intensive processes required by the global automotive industry.

- The fail in catching up due to this structure depending on global players make us offer the term "middle-technology trap", prescribing the case of latecomers (mainly, say, developing countries) in industries involving middle-high technologies.

We assert the view that all these findings summarized till now provide a good-basis for us to provide policy conclusions.

7.3. Policy recommendations

To provide policy recommendations, it is plausible for us to utilize the results proposed in the preceding section. We separate this section under three related sub-headings, offering the measures in accordance with what has been outlined in Chapter 2. In this section we aim at building up some measures for policy-makers. Table 19 summarizes the results and policy actions.

Table 19 Policy recommendations for Turkey to overcome the mid-tech trap

	Policies towards firms	**Policies towards facilitators**	**Government strategy towards catching up**
Objectives	• to support supplier SMEs by developing their capabilities on the level of co-designer and to increase the quality and quantity of engineering and design firms • to increase the quality and quantity of firms having core-businesses on contemporary technology • to support JVs and foreign affiliates to perform R&D with the aim of having royalties	• to facilitate umbrella organizations that enhance knowledge dissemination • to generate and enhance complementary institutions in NIS • to solve hard and soft infrastructure problems involving intellectual capital or facilities such as wind tunnels and test centres	• to establish national brand that is capable of producing end products in niche segments with a joint consortium of firms, umbrella organizations and government by using complementarities among them • to bring national champions from currently established firms by monitoring their development during subsidization schemes • to support national OEMs to provide knowledge dissemination and capability building throughout the system • to fulfil the gaps in NIS to generate an efficiently working one by providing physical infrastructure, qualified intellectual capital and complementary institutions • to attract FDI directed towards establishing new plants involving R&D centres
R&D	• to facilitate R&D performance by designing new subsidization programmes by monitoring firms to reach a co-designer phase. • to designate new subsidization schemes to provide incentives for firms specialized in contemporary technologies • to support entrepreneurship and university-industry collaboration to generate new ventures on design and engineering • to generate new subsidization scheme focused on incentives for domestic JVs and foreign affiliated firms in order to have royalties and to attract core parts of global R&D projects	• to use umbrella organizations for collaborative R&D • to support joint consortiums by government, umbrella organizations and firms to provide R&D infrastructure	• to designate subsidization schemes for the efforts of sophisticated R&D • to alter current approach of subsidization towards co-designing by enhancing firm capabilities and intensifying knowledge flows from global OEMs. • to encourage the R&D activities of JVs to have royalties by participating into global R&D projects of headquarters

Table 19 Policy recommendations for Turkey to overcome the mid-tech trap (continued)

	Policies towards firms	**Policies towards facilitators**	**Government strategy towards catching up**
Technology	• to break down the lock-in situation of domestic auto-suppliers on traditional technologies by adopting emerging technologies towards system design • to use signalling strategies and demand sided policies to provide incentives for R&D on state-of-the art technologies	• to bring centre of excellence institutions on automotive technologies to build up a bridge between invention and innovation • to attract foreign engineering and design firms to create knowledge dissemination • to generate projects based on basic R&D with the establishment of joint-consortiums involving firms, R&D centres, universities and facilitator institutions.	• to draw roadmaps for state-of-the-art technologies by common consensus and participation of concerning agents in the system • to implement signalling strategies and demand-sided policies in order to flourish emerging technologies • to stimulate firms to a transition in their core businesses involving contemporary technologies
Networking	• to create awareness on firms towards joint-projects based on collaboration and complementary assets and capabilities	• to generate networking services to meet up concerning bodies in the system to generate state-of-the art projects • to use umbrella organizations to get together complementary assets and capabilities of firms, universities and complementary institutions • to enhance supplier networks by using facilitator institutions to create more efficient OEMs and national champions	• to reward networking efforts by firms, umbrella organizations, complementary institutions

7.3.1. Current outlook of automotive industry and solutions for Turkey

As we outline the current conditions of the global industry and their effects on the Turkish Automotive Industry structure, we found a highly dependent structure of domestic industry both as JV and procurer on global OEMs, predominantly on the fields of design and commercialization. For the sake of national industry, this dependence should be overcome by enhancing Turkish R&D without detaching it from the global knowledge flows.

For enhancing JVs, we have previously offered to implement measures to make them aware of having royalties to increase their value-added. Government should implement thematic funding schemes, particularly supporting such initiative of Turkish JVs. R&D centres of JVs should furthermore be supported in this sense. Complementary factors to attract these projects, such as proper intellectual capital and infrastructure should be developed by the joint consortium of Turkish JVs and the government. Wind tunnels, test and analysis centres of such kind are examples of infrastructure developments that may empower such initiatives as well. Current subsidization programmes of TUBITAK open to wide participation of Turkish JVs such as TUBITAK 1501[105] and TUBITAK 1511[106] are supply-sided and should be altered by focusing on the royalties rather than subsidizing only eligible projects. We criticize the current scheme and strongly consider that an altered approach involving aforementioned aspects should be at the focus. Furthermore, projects that are prone to knowledge dissemination to domestic suppliers may be granted forward with extra margins to provoke dissemination of knowledge throughout domestic industry. Signalling strategies might be deployed to direct Turkish JVs into basic research and development projects by rewarding them with several grants. This would also take attention of the headquarters to mobilize their basic research for future technologies

[105] TUBITAK 1501 is a subsidization programme providing grants that has no upper limit for each type of Turkish firm with different sizes and capabilities. Further information is available at: http://www.tubitak.gov.tr/tr/destekler/sanayi/ulusal-destek-programlari/icerik-1501-tubitak-sanayi-ar-ge-projeleri-destekleme-programi

[106] TUBITAK 1511 is a subsidization programme providing grants on the area of emerging technologies. It is a thematic funding programme and further information can be found at: http://www.tubitak.gov.tr/tr/destekler/sanayi/ulusal-destek-programlari/icerik-1511-tubitak-oncelikli-alanlar-arastirma-teknoloji-gelistirme-ve-yenilik-p-d-p

into Turkish affiliates. A similar case is observed in the incentives for the R&D centres under law numbered 5746. These state supported R&D centers increasingly attract R&D projects from the headquarters.

For the suppliers in Turkey, policy-makers should design programmes to boost the local firms to act as co-designer by performing more sophisticated R&D with intensifying knowledge flows from global OEMs. Such schemes should be objective-oriented rather than solely financially supporting the projects. The funding institutions should be able to monitor the capability building process of procurers instead of only evaluating the eligibility criteria of the R&D projects. Such kind of new subsidization approach requires institutional change (either a change in the existing structure or forming new institutions). This institutional change could be brought by the provision of highly qualified experts that are able to monitor the firms. It requires attractingqualified experts having wider experience in the automotive industry by providing them more competitive salaries and more attracting job conditions. There is one more difficult challenge to cope with. The institutional change could only be achieved with the new mindset in the current institutions by changing their organizational structures, having more capable of monitoring firms' capability building. It requires finding out, adopting and implementing new methodologies to manage this challenging work. Government initiative is signficantfor such a policy design to be successful.

OEMs play a key role in establishingnetwork and disseminate knowledge. In our case study, we have reached the information that domestic OEMs are more open to disseminate their know-how to domestic procurers compared to foreign OEMs. For this reason, promoting domestic OEMs and increasing their numbers seem important. Since building domesticOEMs may necessitatehigh start up investment, government intervention on the market may be required. It is a challenge expectedly, but for the reasons proposed, we find the ongoing discussion of establishing a national brand meaningful in this sense. Building up a national brand and launching Turkish car models are technologically achievable in Turkeyregarding the current manufacturing excellence. However, it also necessitates product portfolio and marketing costs abroad that seems to be compensated by government intervention.

So, the designation of such an initiative might be launched very firstly on the field of *a niche product* such as Karsan's V1 Taxi project. This initiative of niche product should deploy current national capabilities, accumulated knowledge and technologic frontier in today's automotive industry. South Korean and Chinese examples might be analyzed to achieve this aim.[107] Nevertheless, we should bear in mind thatthis would be a hard task to succeed unless proper protectionist measures are implemented till the infant firms would grow. The process could also involve some restrictions imposed by GATT Agreements and general tariffs by WTO in this sense. Prospective infant firms might be subsidized by public procurement or the subsidization scheme may be altered to provide before an R&D project starts as we think of financial constraints an infant firm possibly encounters.Another challenge is to establish a successful supplier network, which is a vital component of successful global automotive brands (Womack et al. 1990). The non-monetary technology policies involving networking, knowledge dissemination through partners, joint projects, joining complementary assets and capabilities of suppliers should be also at the focus to increase the chance of successful national venture on establishing an automobile brand. We are aware that this new approach in policy also requires cognitive change on the firm basis and in the industry as a whole by providing awareness of collaboration between agents involving not only firms; but also institutions, umbrella organizations and government as well.We consider that umbrella organizations should be more proactive in taking this role.

Turkish subsidization scheme is currently working upon the application of firms. Firms offer their project applications in accordance with their current experiences and problems. We strongly consider that this way of collecting R&D proposals might be helpful in solving problems of the current state of mind of the actual players but in fact, achieving sophistication in R&D activities should involve problems belonging to state of the art technologies. Here, we propose to use signalling strategies by the government to provide incentives in order to flourish state of the art technologies required by the global automotive industry. R&D activities involving such kind of initiatives should be supported by different

[107]Please see Wang and Kimble (2013), L. Kim (1997) in Chapter 2.

programmes with the provision of additional bonuses to the performers. At this point, we offer to give additional bonuses by increasing the subsidization rate up to 100 percent of project budget. As mentioned, providing subsidization money before a prospective R&D project starts would be another incentive for the project performer.

7.3.2. Firm strategy and micro solutions for Turkey

The case studies have also provided micro evidences regarding how firms can be supported to establish a more sophisticated technology base. We have asserted that firms specialized in contemporary technologies have more opportunity to differentiate their core businesses while firms with traditional technologies may possibly encounter a kind of lock-in problem sourced by their core businesses. With this fact in mind, we assert the subsequent measures.

Firms specialized in contemporary technologies should be increased in numbers. A transition of traditional firms might be too difficult to realize; then, it is reasonable to produce new generation of automotive firms that would be specialized in these emerging technologies. Policy-makers are supposed to implement signalling strategies and demand-side policy measures without neglecting to put forward technological roadmaps drawn by common consensus. For instance in the case of Vision 2023 strategic plan there was no proper guidance of a government organization. Such kind of technology roadmap should be reinitiated to lead signalling strategies. Entrepreneurship focusing on these new fields should be supported in a framework of university-industry collaboration. Demand-sided policies by using government procurement in this technology fields should be implemented to enhance these new ventures to empower national infant industries (List, 1841).

Design, engineering and consultancy firms are vital to develop the general R&D capacity of Turkish industry. Rather than promoting the capability of R&D throughout procurers or JVs, it could also be supposed to subsidize such firms to boost the national performance. The affinity of domestic firms to collaborate with these firms is infact an asset that the government should seriously benefit from. For

example, joint projects in this sense might be awarded with additional grants and bonuses to provoke those types of joint R&D efforts.

7.3.3. Catching up, leapfrogging and macro solutions for Turkey

As the literature review has proposed, Turkey should run faster than the forerunners to catch up but the evidence in this thesisdo not provide such kind of a performance. Case studies in Chapter 5 and 6 also suggest that Turkey is not yet ready to leapfrog. We argue some policies how to succeed in them as given below.

In terms of catching up, we alreadyproposed policies that will enable a more independent automotive industry in terms of R&D context and innovation decisions. In addition, attracting FDI as a macro policy measure would be helpful if the objective of the FDI also involvesestablishment of R&D centres. Attracted FDI should be directed towards new investments rather than investment in the capacity that is already present(i.e., buying state owned enterprises, mergers and acqusitions etc.). Growing the automotive industry requires establishing new plants with increased capacity to enlarge the share of domestic industry in the world trade. At this point, Lee and Lim's (2001) model of technological and market catch up should not be neglected as it proposes accompanying market success with technological adoption for a successful catch-up process. The crucial point is that the government should support the new FDI-led investment that is relatively independent of foreing affiliates in terms strategic decisions such as R&D and innovation.

For leapfrogging, the situation is of course more demanding. It requires a comprehensive outlook for the whole industry to monitor emerging technologies. Here, the government intervention seems as an indispensible tool for directing the national industry to perform R&D activities on such technologies (policy that affects the direction rather than the rate of technical change). To select the kind of leapfrogging type that is convenient for Turkey is of course a challenge. Regarding its latecomer position, Turkey seems to be in need of a more accelerated path of technological development such as path-creating and paradigm-changing leapfrogging, which requiresfilling some conceptual gaps with the forerunners. At first, these types of leapfrogging necessiate an efficiently working innovation system

by providing complementary institutions, overcoming lock-in problems and altering policy measures. Focusing on emerging automotive technologies such as component design on electrical vehicles and niche product concepts on vehicles may give someopportunities to Turkeyto fullfill such types of leapfrogging.Since, for instance, electrical vehicles and their components donot have dominant worldwide design Turkey can base its strategy on these niche areas. In addition, rather than sole subsidization as supply-side policies, signalling strategies and demand-side policies should be employed to support contemporary technologies such as alleviation of car weights with composites, new electronic systems for safety and security, electrical vehicle systems etc. Not only developing them, but also the environment suitable to the commercialization of these technologies is required. This requirement triggers the need for complementary policies and institutional change throughout the innovation system (policy mix rather than individual policy tools). Here, without defyingthe rules of the international system, protectionist measures should be carefully implemented to infant emerging technologies.Public procurement on emerging automotive technologies and supporting entrepreneurship, for instance, on design and engineering firms with the provision of additional grants and bonuses might be helpful to achieve this aim. New business models may be sought like in the Japanese and Korean cases to market the products under a domestic brand. We consider that business model generation, which is a vital component of market success for R&D projects, is generally omitted by the domestic industry. This impediment should necessarily be dealt with.

7.4. Conclusion

In this dissertation, using both quantitative and qualitative methods, we argue that Turkey is not able to catch up forerunners of the automotive industry because it is not able to sophisticate its R&D projects. The current organization of the domestic industry is dependent, to a great extent, on global decision-makers for both R&D and commercialization. Despite the ongoing learning in manufacturing in the post 1990 era, we cannot say that the Turkish automotive industry has a potential to catch-up with the forerunners or leapfrog predominantly observed in the South Korean case.

This result led us to define the state of Turkey as being in a "middle-technology trap". This concept can be defined as:

> Middle-technology trap is *a state when* a country is locked into traditional fields of technology (middle or middle-high technologies)where the country's own tangible and intangible resources are not sufficient to change the rules of the global organization to become a major player in strategic decision-making in R&D, innovation and new technology development.

This argument is supported by our case studies, explicating Turkish firms' dependence on their outsourcers in terms of R&D and commercialization and the adopters of traditional technologies to transform their core businesses towards emerging automotive technologies. Our argument is further enhanced by the ongoing discussion regarding that Turkey is in fact in middle-income trap. By using our arguments throughout the dissertation, in Figure 11,we show technological sophistication of the Turkish Automotive Industry related to different time-periods in order to illuminate the concept of middle technology trap.We also put future projections of two different paths – an optimistone that can overcome the middle-technology trapwhichwould enable to move towards the world technology frontier and a pessimist one that would probably point at the demise of the automotive industry (for instance, the case of Detroit).

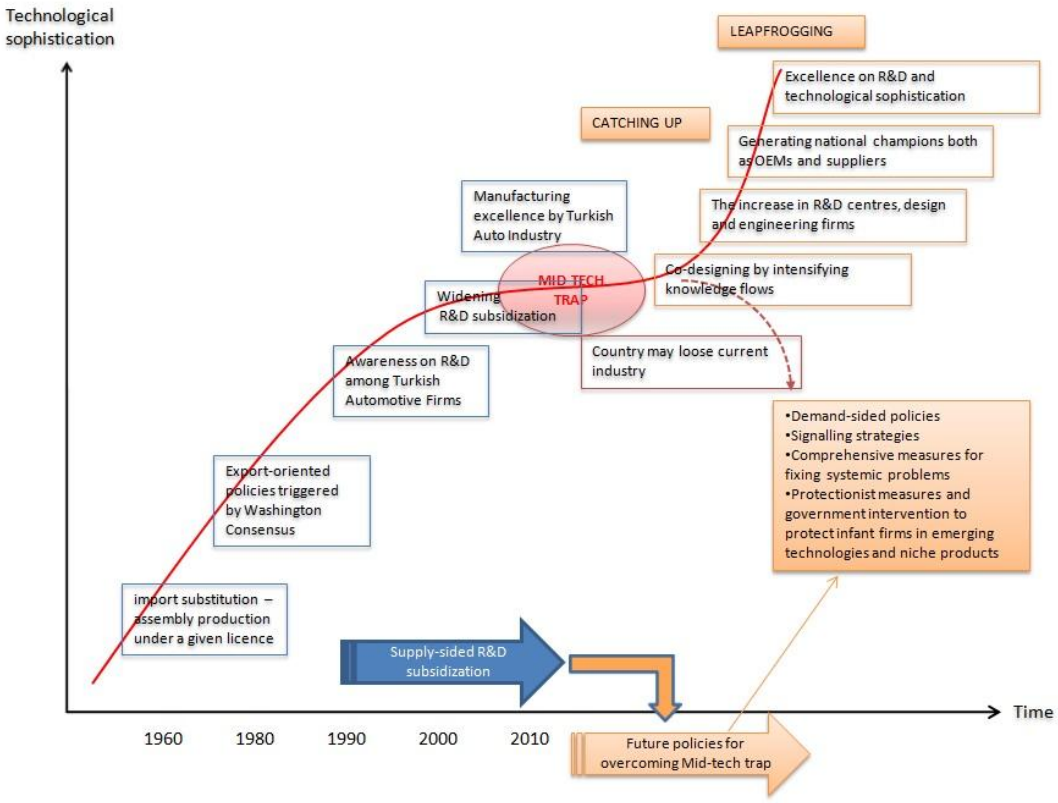

Figure 11 The path of Mid-tech trap in Turkey and policy recommendations to overcome it.

Figure 11 shows how Turkish Automotive Industry has fallen into mid-tech trap; and how we can overcome it. Turkey started to sophisticate its automotive production technologies nearly from scratch by starting with import substitution policies. During 1960s, Turkey produced assembly cars under given licences from the global OEMs. Once therules of Washington Consensus came into force Turkish industry including automotive passed into an export-oriented regime. It triggered the terms such as competitiveness, quality, and cost reduction within the perception of the domestic industry. This was accompanied by the emergence ofR&D and innovation activities by domestic firms. Throughout the 1990s, R&D awareness increased as a result of the supply-sided R&D subsidization programmes of TTGV and TUBITAK. Subsequently, 2000s saw a significant intensification in R&D activities of Turkish Automotive Industry. All these efforts carried on Turkey on a level of manufacturing excellence about the year 2010. Turkey has managed to

manufacture in world standards with high quality and desirable costs. Nevertheless, the reasons stated all along the chapter, such as strong dependence on global OEMs in R&D activities and their commercialization, systemic problems in innovation system, lock-in problems on current traditional technologies and unaltered policy regime have brought Turkey to the state of 'middle-technology trap'. We assert that Turkey may loose its current industry unless convenient measures implemented as seen in Figure 11.

To overcome this trap, we argue that Turkey needs a new policy outlook. We strongly recommend demand-sided policy measures and signalling strategies for flourishing state-of-the art automotive technologies in Turkey. By designating demand-sided public procurement in the emerging and contemporary technologies of the automotive industry such as electrical vehicle component design, developing composite alloys that are capable of reducing vehicle weight, performing system designs that are capable of being adopted to the products of global automotive manufacturers etc., Turkey may create new firms in niche products that are able to compete in flourishing technologies of automotive. It also accelerates new technology adoption in the Turkish Automotive Industry by enhancing the level of intellectual capital. Those kinds of projects should be subsidized in a different manner rather than the current scheme[108] by providing subsidization money before the project begins since these projects require stronger initiatives financially. Signalling strategies should also be implemented to basic research and development in similar areas. The success in these policy measures might give Turkey the opportunity of path-creating and paradigm changing leapfrogging by filling the conceptual gap requiredas outlined in Chapter 2. Research on contemporary and future technologies would give the capability to foresee future technologies and successfully manage the direction and rate of technological change. Similar toprojects in signalling strategies, these kinds of projects should be subsidized with

[108]Current schemes of R&D subsidization in Turkey generally compel the firms by insisting on them to spend money for R&D before subsidization. It generates finacial problems especially on projects that have higher risks.

the provision of money before the project starts; and furthermore, should be subsidized up to 100 percent.[109]

To clarify the dependence on foreign decision makers, we propose to establish domestic OEMs and suppliers that are capable of being national champion with a different understanding of policy approach including protectionist measures, to some extent. By monitoring the capability development of R&D performers in Turkey, rather than subsidizing the similar projects, Turkey should subsidize their successful firms *smartly* by controlling their R&D projects and outputs in a convenient methodology in order to check them whether they are reaching a new phase in the global automotive value-chain. For example, a firm that is capable of designating R&D projects on traditional technologies should be further supported only if it is able to advance its projects by adopting contemporary technologies. In addition, suppliers, for instance, should be subsidized only if their R&D projects are capable of transforming themto a co-designer. These supports that are capable of bringing Turkish firms at the upper tiers might compel the free-trade agreements.[110]It requires protecting prominent firms under this new policy schemes if these firms have potential to reach the phase of national champion. However, note that this proposition does not refer to close Turkish industry to free trade; in contrast, we offer to implement policy measures towards attracting FDI in order to intensify global knowledge flows in the domestic industry. One vital element to accomplish this is to fix systemic problems in the Turkish innovation system by overcoming infrastructure problems, lack of intellectual capital by enhancing education and vocational training, providing complementary institutions etc. as asserted in the preceding sections. These policy tools under a carefully designed policy mix may help to overcome the mid-tech trap that the automotive industry faces. One impediment to this might be the current organization of R&D funding institutions intheinnovation system. They are used to implement supply-sided policy meausures

[109] As outlined by Nelson (1959), research on basic fields of technology have higher risks; hence they should be provided more incentives than others.

[110] We strongly consider that this proposition is reasonable if a reader might take into account the government intervention ruled by the US government on General Motors and Chrysler in order to rescue them from bankruptcy during the Global Economic Crisis of 2008.

focusing on horizontal subsidies and more or less thematic funding to some extent. Our proposal requires changing the current institutional setting with a new outlook. For example, new policy approach outlined would require institutions, having personnel that are capable of evaluating the firms' capability development. To educate such kind of experts and to persuade them to work for the public institutions is another challenge to cope with as we think of the current working conditions in public sector. Another problem would be to change the organizational structure of the main policy setting institutions. A solution to this might be establish a brand new institution that is responsible for designating and implementing this new policy approach.

Further research should include deepening this research investigating other developing countries. The case of countries in the middle income trap should be analysed to build up a concrete bridge between middle-technology trap and middle income trap. We consider that such kind of initiative would be useful to expand understanding behind the middle-income trap by putting technological development at front.

To conclude, we are confident that we have explicated some of the bottlenecks of the national automotive industry from a different perspective. We hope that policy conclusions and key concepts proposed in this chapter would be a solid contribution to the current literature and would offer some insights for policy-makers.

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APPENDICES

Appendix A: Petition for Joint Ventures via OSD

PETITION FOR JOINT VENTURES VIA OSD

Date : 25.07.2012

Number : TTGV(2012)3-1038

THE ASSOCIATION OF AUTOMOTIVE INDUSTRY (OSD)

GENERAL SECRETARY

ISTANBUL

Subject :Data Request for a Ph.D. Thesis, namely, "Technology Development of Turkish Automotive Industry: A Case of Middle-Technology Trap".

Mr. Ercan TEZER,

An expert, namely Mr. Serkan Bürken, who is working for our foundation, is sustaining his Ph.D studies in the department of Science and Technology Policy Studies in Middle East Technical University (METU) and needs some data provision on the topics provided below. Please ensure that the data, if provided, will be used under the thesis studies mentioned above and will be confidential. No firm and

trademark information will be mentioned under the data being used in the thesis due to the provision of full confidentiality.

We kindly request you to gather convenient permissions from a convenientJoint Venture firm under your association as a member in order to take the plausible data.

Kind Regards,

Mr. Yücel TELÇEKEN

Coordinator of Technology Development Projects Group

Technology Development Foundation of Turkey

REQUESTED DATA FROM A JOINT VENTURE IN TURKEY

As we consider, a vehicle is composed of the components given below; the aim of the study is to calculate the input costs of a vehicle and the value-added being created for the given vehicle by regarding its selling cost. Furthermore, the other aim is to find out the origins (nationality) of intermediary components and parts being used in the vehicle. The types of suppliers of intermediary inputs are given below as:

a) Domestic suppliers
b) Foreign suppliers (the nationality of the supplier)
c) Firm manufactures on its own
d) Procured by the headquarters of the given JV (the country in which the part is produced)

If the data is provided, a value-added analysis is to be performed and the national origins of common suppliers are to be put forward. For attaining this aim, we kindly request to be fulfilled the table provided below.

Table A Auto-parts requested to be filled by JV

Part Code[111]	Part Name	Input cost (TL)	The type of supplier (a/b/c/d - Nationality)
A	BODY		
A1	Chasis		
A2	Painted sheet part		
A3	Suspension System		
A3.1	Springs, stabilization road		
A3.2	Gas spring		
A3.3	Swing arm		
A3.4	Steering knuckle		
A3.5	Axes		
A4	Steering System		
A5	Brake System		
A6	Pedal		
A7	Air-conditioning system		
A8	Fuel tank		
A8.1	Fuel Tank (sheet material)		
A8.2	Fuel Tank (plastic material)		
A8.3	Fuel Tank System		
A9	Radiator (Cooling System)		
A10	Alternative Fuels		
A11	Engine Control Unit		
A12	Cable System		
A13	Exhaust System		
A14	Command wires		
B	BODY EQUIPMENT		
B1	Inner-trim parts		
B1.1	Seats		
B1.2	Door panels		
B1.3	Dashboard/console		
B1.4	Roof coating		
B1.5	Inner plastics		
B1.6	Carpets		
B1.7	Inner handles		
B1.8	Door handles		
B1.9	Voice and heat isolation		
B2	Outer Trim Parts		
B2.1	Bumpers		
B2.2	Side sticks		
B2.3	Glasses		
B2.4	Attachments		
B2.5	Outer plastics		
B2.6	Wipers		
B2.7	Mirrors		
B3	Movable Parts		
B3.1	Doors		
B3.2	Door Locks		
B3.3	Hinges		
B3.4	Glass mechanisms		
C	ELECTRIC AND ELECTRONICS COMPONENTS		
C1	Radio		

[111] Part codes and classification is quoted from an unpublished study of Tülay AKARSOY ALTAY (2004), namely "Sektörel Teknolojik Durum Değerlendirmesi – Otomotiv Ana Sanayi Çalışması Sonuçları". This study was being performed with several scholars who have deep expertise in automotive industry.

Table A Auto-parts requested to be filled by JV (continued)

C2	Wiper engine		
C3	Antenna		
C4	Lumination System		
C5	Horn devices		
C6	Signal command		
C7	Assurance box		
C8	Immobilizer		
C9	Indicators/Warnings		
C10	Electrical glass mechanisms		
C11	Accumulator		
C12	Alternator		
D	SAFETY COMPONENTS		
D1	Safety belt		
D2	Airbags		
D3	Active security		
D3.1	Electronic Stability Programme		
D4	Passive security		
E	ENGINE		
E1	Cylinder Block		
E2	Cylinder Head		
E3	Cam shaft		
E4	Piston		
E5	Crank shaft		
E6	Ignition System		
E7	Injection System		
E8	Systems for avoiding emissions		
E9	Lubrication System		
E10	Cooling System		
E10.1	Fan		
E11	Air Absorption System		
E12	Crankcase Ventilation System		
E13	Turbocharger		
E14	Exhaust Aftertreatment		
E15	Joint ring and seal ring		
E16	Intercooler		
F	TRANSMISSION COMPONENTS		
F1	Gear box		
F2	Axle gear		
F3	Clutch		
F4	PowerTrainSupport		
G	OTHER FIELDS		
G1	Recyclability		
G2	Telematics		
	Please state other part or component costs, if there exists.		

Kind regards,

Serkan BÜRKEN

Expert – Technology Development Foundation of Turkey

METU Science and Technology Policy Studies – Ph.D. candidate - 1454073

Appendix B: Indicator and sub-indicator measurements in an alternative timeframe

Alternative Periods	1996-2003	2004-2011	1996-2003	2004-2011
Total # of projects	16	70		
Innovation Level				
Firm	5	32	0,31	0,46
National	11	33	0,69	0,47
International	0	5	0,00	0,07
Technology field				
Traditional	11	48	0,69	0,69
Contemp.	4	22	0,25	0,31
Both	1	0	0,06	0,00
Market Orientation				
Domestic	4	13	0,25	0,19
Abroad	5	8	0,31	0,11
Both	6	48	0,38	0,69
NA	1	1	0,06	0,01
Design intensivity and OEM presence				
Non-existent	1	2	0,06	0,03
Specs by OEM	3	23	0,19	0,33
Design Exist.	12	45	0,75	0,64
Innovation type				
Process	1	12	0,06	0,17
Product	15	42	0,94	0,60
Both	0	16	0,00	0,23
Customers of project output				
OEMs and JVs	10	40	0,63	0,57
Other	6	30	0,38	0,43

Appendix C: Questionnaire for Firm Visits

QUESTIONNAIRE FOR FIRM VISITS

The interviews with firms were held by posing the questions by dividing them into four sub-headings. The complete questionnaire is given below:

a) R&D context:

a1) Why do the firm perform R&D? (product or process innovation; the origin of the performed innovation is ignited by the market signals or from the needs of the firm)

a2) What is the main objective of performed R&D? (productivity or design; R&D or product development). Do the firm perform concept design? Is there any efforts towards experimental R&D?

a3) Does the firm think that they perform R&D on the state-of-the-art technologies that would possibly affect the future of the automotive industry? Is there any sign of development in this direction in the projects they are to perform?

a4) Is there any projects performed by the firm in niche technologies?

a5) Does the firm perform R&D for its weak or strong ties?

a6) Is there any projects for given firm that is subsidized by EU or that have foreign R&D partner?

a7) Is there any performed R&D projects of the firm that is outsourced by a MNE or OEM?

a8) What have been the last five R&D projects that has been performed by the given firm in terms of their context, budget, targeted market and revenue?

b) R&D output

b1) What has been the market success of firm's finished R&D projects?

b2) Is the firm only decision-maker in the commercialization process (to which customer it is to be sold out; or how many pieces are to be sold out) of the performed R&D outputs?

b3) Have the performed R&D projects provided new employment and investment? Have they triggered new R&D projects within the firm?

b4) Do R&D projects involve export orientation? Is there any emerging inclination towards this end?

b5) What about the export markets? Is there any tendency in export markets towards sophisticated ones like EU and the USA? If so, have R&D programmes helped the firm in this sense?

b6) What are firm's successful projects? What do they involve compared to unsuccessful ones?

c) Firm strategy towards innovation

c1) Is there any area in which the firm has been specialized? Is the firm getting specialized in its core business? Is there any intention of firm to be specialized in a more specific area of expertise?

c2) If the firm is procurer, does it procure a system, a component or solely a part of the car?

c3) Have the firm been attended to the specific field subsidization calls of TUBITAK?

c4) Do the firm perform R&D towards compensating an uncompensated need or penetrating into a niche market?

c5) For the R&D projects assigned by OEMs or MNEs, have the firm taken specs from the assigning entity or have it designed or co-designed the project output?

c6) (For JVs interviewed) What part or in which area of specialization of an R&D project is being assigned to domestic JV? What are the responsibilities do Turkish JVs charged?

c7) Have there been any projects of the firm towards pre-competitive collaboration?

d) Firm opinions about R&D subsidization in Turkey

What do the firm consider about possible measures to be implemented to take a position in higher value-added parts of the global value-chain with more sophisticated products? What should be done in terms of R&D policies and subsidies?

Appendix D: Questionnaire for Expert Interviews

QUESTIONNAIRE FOR EXPERT INTERVIEWS

The questionnaire held for expert interviews was involved with the questions below:

a) How does the interviewee see the historical evolution of Turkish automotive industry? What were the turning points, what were the milestones in the past? (The most important three of them) Were there any rights or wrongs that had affected the development of the sector on both policy side and industry side?

b) In current situation, how is the industrial structure? To where and which direction through global industry does it evolve? What are the strengths and weaknesses (design, R&D, manufacturing, marketing etc.)?

c) What is the industrial position in R&D? Do R&D schemes support the innovations and technological developments in the domestic industry?

d) How is the interviewee positioning the sector in global industry? Positive or negative impression he or she has about the sector with respect to emerging BRIC countries and newly industrialized South Korea? How does he/she see the national relative position in global industry? Is there a catching up in terms of technology? What are the connection between design, R&D and manufacturing processes held in industry and sectoral position? What are the effects of JV-dominated structure of the industry on its development?

e) How can the findings of technological sophistication be checked or validated? Is there any possible way to be recommended? What should the further investigation on firm basis involve? What should be the context of firm-based case studies?

Appendix E: Vita

CURRICULUM VITAE

PERSONAL INFORMATION

Surname, Name: Bürken, Serkan
Nationality: Turkish (TC)
Date and Place of Birth: 10 February 1980 ,Izmir
Marital Status: Single
Phone: +90 312 266 21 96
Mobile: +90 533323 64 20
email: sburken@ttgv.org.tr

EDUCATION

Degree	Institution	Year of Graduation
MS	METU, Science and Technology Policy Studies	2007
BS	DEU Mechanical Engineering	2004
High School	Buca Anadolu High School, Izmir	1998

WORK EXPERIENCE

Year	Place	Enrollment
2008- Present	TTGV	Expert
2005-2008	TEZMAKSAN Machine Co.	Area Manager

FOREIGN LANGUAGES

Advanced English, Basic French

HOBBIES

Sports, Music, Columnist

Appendix F: Türkçe Özet

TÜRKÇE ÖZET

1. Giriş

Bu tezde Türk Otomotiv Sanayi'nin eriştiği teknolojik sofistikasyon seviyesi niceleyici (kantitatif) ve niteleyici (kalitatif) vaka çalışmalarından oluşan özgün bir yöntem ile incelenmiştir. Böylece her iki yöntemin kısıtlayıcı yönlerinin üstesinden gelinerek Türk Otomotiv Sanayi'nde Ar-Ge projelerinin bütüncül bir değerlendirmesinin yapılabileceği düşünülmüştür. Teze, Türk Otomotiv Sanayi'nde gerçekleştirilen Ar-Ge projelerinin daha geleneksel teknolojiler içeren benzer projelerden oluştuğu izlenimi ile başlanmıştır. Tezde genel çerçeve olarak, yazında (literatür) bulunan, bilim ve teknoloji politikası ve kalkınma çalışmalarında kullanılan öndekini yakalama (catching up) ve sıçrama (leapfrogging) kavramlarından yararlanılmıştır. İlgili çerçeveye uygun olarak öncelikle bir teknolojik sofistikasyon tanımı yapılmıştır:

Teknolojik sofistikasyon, yüksek katma-değerli, otomotiv endüstrisinin çağcıl teknoloji alanlarında gerçekleştirilen, yurtdışı OEM'lere ve müşterilere bağlı olmadan tasarım-yoğun ürünler ve süreçler içeren Ar-Ge projelerinin üretildiği bir durumdur.

Bu tanıma uygun olarak tez kapsamında bir adet kantitatif ve iki adet kalitatif çalışma gerçekleştirilmiştir. Kantitatif çalışma kapsamında Türkiye'de ilk Ar-Ge desteklerini sağlayan kurum olan Türkiye Teknoloji Geliştirme Vakfı (TTGV) arşivinde bulunan 102 adet Ar-Ge projesi değerlendirilmiş ve bunlardan 86 adeti tez kapsamında kullanılmıştır. Bu projelerin başvuru ve gerçekleşme tarihleri 1991-2011 yılları arasını kapsamaktadır. Çalışmadan varılan ana sonuç, Türkiye'de otomotiv endüstrisinde benzer ve daha geleneksel teknoloji alanlarında Ar-Ge projeleri yapıldığıdır. Buna göre; 1990 sonrası dönemde Türk Otomotiv Endüstrisi sağladığı ihracat başarısına rağmen; bir öndekini yakalama performansı

sergileyememiştir. TTGV verilerinin bazı sınırları düşünülerek doğrulama ve çalışmayı genişletme çalışması olarak firma ziyaretleri ve uzman mülakatları gerçekleştirilmiştir. Firma ziyaretleri kapsamında TTGV'ye başvuru yapmış ve proje bilgisine ulaşılan 13 ayrı firmanın Ar-Ge Müdürleri ve üst düzey yetkilileri ile yarı yapılandırılmış mülakatlar tertip edilmiştir. Uzman mülakatları kısmında ise, Türkiye'de otomotiv sektöründe geniş bir tanınırlığı, tecrübesi ve bilgisi olan 14 ayrı uzman ile yine yarı-yapılandırılmış mülakatlar düzenlenmiştir. firma ziyaretlerinden Türk Otomotiv Sanayi ile ilgili mikro bulgulara ulaşılması planlanırken, uzmanlardan da tarihsel süreçte makro bulgular elde edilebileceği düşünülmüştür.

Çalışma kapsamında sorulan ana araştırma sorusu şöyledir:

Daha sofistike ve bilgi temelli Ar-Ge projeleri geliştirerek Türk Otomotiv Sanayi daha gelişkin ürünler üretebilecek ve tasarlayabilecek seviyeye erişmiş midir? Bu kapsamda, bir öndekini yakalama ve sıçrama sürecinden bahsedilebilir mi?

Takip eden bölümde, yapılan vaka çalışmaları ile ilgili ana bulgulardan bahsedilecek ve daha sonra bu bulgulardan sonuçlar elde edilecektir. Bu sonuçlar üzerine de literatürde mevcut olan politika araçları kullanılarak Türkiye için bazı politika önerileri geliştirilecektir. Özet kısmı, orta-teknoloji tuzağı ismini verdiğimiz ve Türkiye'nin durumunu açıkladığını düşündüğümüz yeni bir terim olan "orta-teknoloji tuzağı" ve bu durumun aşılması için yapılması gerekenlerin tartışılması ile sonlanacaktır.

2. Vaka çalışmalarından elde edilen bulgular

Yukarıda da bahsedildiği gibi ilk vaka çalışmasında TTGV'nin arşivinde bulunan 86 adet otomotiv Ar-Ge projesi başvuru dosyası içlerinden titizlikle veriler toplanarak ve bunun uygun yöntemlerle ölçülmesiyle değerlendirilmiştir. Bu değerlendirme kapsamında edinilen bulgular aşağıdaki gibi özetlenebilir:

- Türkiye'de gerçekleştirilen Ar-Ge projelerinin yenilik düzeyi ulusal seviyede kalmaktadır. Genel olarak, dünya çapında etki yaratabilecek projelerin gerçekleştirilmesine yönelik bir geçiş gözlenmemiştir.

- Otomotivde yükselen eğilimlere uygun çağcıl teknoloji alanlarında gerçekleştirilen projelerin sayısı çok azdır. Sanayide gerçekleştirilen projeler geleneksel teknoloji alanlarında yer almaktadır ve daha çok verimlilik odaklıdır.
- Veriler, Türk Otomotiv Sanayi'nin ihracat odaklı çalıştığını doğrulamıştır. Fakat projeleri farklı ve daha sofistike pazarlara girme ve buralarda rekabetçilik sağlama gibi olumlu etkileri gerçekleştirdiğine yönelik yeterli veri sağlanamamıştır.
- Gerçekleştirilen projelerde gerek bilgi sağlayıcı gerekse müşteri olarak yurtdışı OEM'lerin oldukça fazla bir etkinliği vardır. Bu durum, gerçekleştirilen Ar-Ge projelerinde önemli düzeyde OEM'lere bağımlılık olduğu sonucunu ortaya çıkarmıştır.

Bu yorumların ötesinde, Türkiye'de firmaların Ar-Ge projelerine ilgisinin ciddi şekilde arttığı tespit edilmiştir. Projelerin gerçekleştirildiği bu 20 senelik dönemde Türk Otomotiv Sanayi'nin ciddi bir öğrenme sürecinden geçtiği sonucuna varılabilir. Fakat eldeki veriler, projelerde bir teknolojik sofistikasyon sağlanabildiğini göstermemektedir. Elbette, mevcut verilerin ciddi sınırlamaları vardır. Yapılan bu çalışmanın sonuçlarının, firma ziyaretleri ve uzman mülakatları ile sınanması düşünülmüştür. O nedenle, tez çalışması aşağıda özetlenen iki kalitatif çalışma ile desteklenmiştir.

Firma ziyaretleri kapsamında TTGV'ye Ar-Ge desteği için başvurmuş firmaların Ar-Ge Yöneticileri ve üst düzey yöneticileri ile yarı-yapılandırılmış mülakat tekniğine göre mülakatlar düzenlenmiştir. Mülakatlar yarım saat ila 1,5 saat arası sürmüştür. Firmaları Ar-Ge içeriklerini, Ar-Ge çıktılarını, inovasyona yönelik stratejilerini ve Türkiye'de Ar-Ge destek süreçleri hakkındaki görüşlerini sınayan sorular sorulmuştur. Bu sorular kapsamında, firma yetkililerinin verdiği cevaplar teknolojik sofistikasyon tanımı çerçevesinde değerlendirilmiş ve bazı bulgulara ulaşılmıştır.

- Türk firmaları Ar-Ge süreçlerinde teknolojik sofistikasyona erişememiştir. Çoğu daha geleneksel teknoloji alanlarında ana yetkinliklerini geliştirmiştir.

Yerli OEM'ler ve büyük firmaların tedarikçileri ile bilgi paylaşımını ve onlara bilgi yayınımını daha iyi gerçekleştirdikleri görülmüştür.

- Boyutuna bakılmaksızın, Türk firmaları Ar-Ge ürünlerinin ticarileşmesi sürecinde yurtdışı büyük firmalara ve OEM'lere bağımlı bir görüntü çizmektedir. Çağcıl teknoloji alanlarında Ar-Ge yapan firmalarda bu bağımlılığa daha az rastlanmıştır.
- Ana yetkinlikleri çağcıl teknoloji alanlarında yer alan firmaların daha sofistike Ar-Ge projesi gerçekleştirmeye daha yatkın olduğu görülmüştür.
- Ana yetkinliklerin geleneksel teknolojilerde olması ve yurtdışı OEM'lere bağımlılık Türkiye'de Ar-Ge projelerinin sofistikasyonunu engelleyen en önemli etkenler olarak tespit edilmiştir.

Uzman mülakatları kapsamında 14 ayrı uzman ile yine firma ziyaretlerine benzer şekilde yarı-yapılandırılmış mülakat tekniğine göre mülakatlar düzenlenmiştir. Mülakatlar kapsamında yine teknolojik sofistikasyon tanımı gözetilerek uzmanlara Türk Otomotiv Sanayi'nin tarihçesi, sanayide uygulanan politikalar, dünyada otomotiv endüstrisinde mevcut durum, gelişmeler ve gelecek yıllarda sektörde hakim olacak teknolojiler gözetilerek sorular yöneltilmiştir. Bu çalışma özellikle teze makro bir çerçeve çizilmesi konusunda yardımcı olmuştur.

Uzmanlar, sektörün ülkemizdeki tarihsel gelişimi konusunda şu ana çerçeveyi çizmişlerdir. Otomotiv endüstrisi Türkiye'de 1960'lı ve 1970'li senelerde ithal ikameci politikaların etkisi altında kalmıştır. Özellikle bu yıllarda montaj sanayinin geliştiği fakat üretimde kalite kavramının yer almadığı tespit edilmiştir. 1980'li yıllarla birlikte dışa açılan Türkiye ekonomisinden otomotiv sektörü de doğrudan etkilenmiştir. Bu yıllarda, otomotiv endüstrisi temsilcileri kaliteli ve rekabetçi ürünler geliştirmenin yollarını aramaya başlamışlardır. Kaliteli ve rekabetçi ürünlerin üretilmesi için gerçekleştirilen arayış, özellikle 1990'lı yıllarda meyvesini vermiş; Türk Otomotiv Sanayi Ar-Ge kavramı ile tanışmıştır. 2000'li yıllarda devlet tarafından verilen desteklerin de artmasıyla Ar-Ge kültürü yaygınlaşmış ve 2000 yılından 2010 yılına kadar geçen süreçte Türkiye otomotivde dünya standartlarında kaliteli üretimin yapılabildiği bir üretim merkezi haline gelmiştir. Fakat aynı şey Ar-

Ge için söylenemez. Türkiye Ar-Ge konusunda halen ortak girişimlerin (joint-venture) ve yan sanayinin küresel karar alıcıların kararlarına tabi olduğu bir görünüm sergilemektedir. Otomotiv sanayinin geleceğine yön verecek teknoloji dallarında gerçekleştirilen Ar-Ge projeleri oldukça azdır.

Türk Otomotiv Sanayi'ndeki mevcut durumda Ar-Ge projelerinin teknolojik sofistikasyonunun geliştiğine dair bir bulguya rastlanmamıştır. Bu durum, yukarıda özetlenen vaka çalışmalarının bulgularını desteklemektedir. Mülakat yapılan uzmanlar, Türkiye'de ortak girişimlerin ana sanayinin gelişmesinde ve belli bir kritik eşiğe gelmesinde çok önemli bir işlev gördüğü konusunda hemfikirdir. Fakat yine aynı uzmanların çok büyük bir kısmı, Türk Otomotiv Sanayi'nin daha fazla gelişimi, daha katma-değerli Ar-Ge projeleri gerçekleştirmesi ve öndekileri yakalayabilmesi için ortak-girişime dayanan bu yapının bir engel teşkil ettiğini ifade etmiştir. Mevcut konsolidasyon ve şirket birleşmeleri ile dünya otomotiv endüstrisi 5 ya da 6 ana firmanın elinde bulunan; giriş ve çıkış engelleri çok yüksek olan bir sanayi dalını temsil etmektedir. Yurtdışındaki büyük otomotiv firmaları ve yurtdışı ortaklar küresel markalarının izin verdiği kadar sorumluluğu Türkiye'deki Ar-Ge departmanlarına vermektedir. Böylece, Türk üreticiler karar süreçlerinde yer almadıkları küresel bir ağda fazla hareket fırsatı bulamamaktadırlar. Sonuçta, otomotiv endüstrisine yön verecek çağcıl teknolojilerin yer aldığı tasarım-yoğun Ar-Ge projelerinin Türkiye'de gerçekleştirilme şansı azalmaktadır.

Sonuçta, uzmanlar diğer ülkelerle karşılaştırıldığında Türkiye'nin otomotiv endüstrisinde öndekini yakalama veya sıçrama yapabilecek bir performans sergileyemediği konusunda hemfikirdir. Örneğin, Güney Kore'de Hyundai ya da Çinli üreticilerin gerçekleştirdiği tarzda bir sıçrama gerçekleştirilememiştir (Lee and Lim, 2001; Wang and Kimble, 2013) Türkiye'de sektörün geleceğini değiştirebilecek tarzda inovasyonlar içeren projelere rastlanmamaktadır (Bower and Christensen, 1995). Devletin teşvikleri olsa da, bunlar Güney Kore ve Çin'dekine benzer şekilde etkili sonuçlar vermemiştir.

Kısaca uzman mülakatlarından elde edilen bulgular şu şekilde özetlenebilir:

- Türkiye'de şu ana kadar uygulanan politikalar Türkiye'yi otomotiv endüstrisinde bir kaliteli üretim merkezi halien getirmiştir. Fakat aynı şey, Ar-Ge için söylenemez.
- Ortak-girişim (JV) firmalarına ve onların etrafından konumlanan yan sanayiye dayalı mevcut yapı özellikle Ar-Ge ve inovassyon süreçlerini ve çıktılarını bir üst seviyeye taşıyamamaktadır.
- Doblo ve Connect modellerinin tasarımı ve üretimi, Karsan New York Taksi projesi ve elektrikli araç bileşenleri geliştirmeye yönelik istisnai bazı projeler dışında Türk Otomotiv Sanayi genel görünüm olarak öndekileri yakalayamamıştır.

Vaka çalışmalarında yukarıda özetlenen bulguları birleştirerek hangi sonuçlara ulaşılabileceği ise aşağıda tartışılmaktadır:

İlk olarak, Türk Otomotiv Sanayi'nin mevcut durumundan başlarsak, ulusal sanayinin dünya çapında üretim yeteneğine sahip bir üretim merkezi haline geldiği söylenebilir. Fakat aynı başarı tasarım odaklı (özellikle pazardan gelen verileri değerlendirerek Pazar odaklı tasarımlar içeren) Ar-Ge projeleri ve çıktıları için söylenemez. Bunun iki temel nedeni vardır: bunlardan birincisi küresel çaptaki otomotiv endüstrisinin mevcut durumudur. Küresel otomotiv endüstrisi yüksek giriş veçıkış engellerine sahip ve önde gidenlerin önemli köşeleri kapmış olduğu bir yapı ihtiva etmektedir. Sonradan gelen ülkeler için bu yapının içinde var olmak hiç de kolay değildir. İkinci neden ise, Türk Otomotiv Sanayi'nin mevcut durumu olarak gösterilebilir. Buna göre; Türk Otomotiv Sanayi ortak-girişim (JV) firmalarının omurgasını oluşturduğu bir konumdadır. Türkiye'ye verilen işler daha çok küresel karar alıcıların insiyatifleri ile gerçekleşmektedir. Türkiye, karar alma süreçlerinde hemen hemen hiç varolmadığı bir sanayi kolunda var olmaya çalışmaktadır. Türkiye'de ortak-girişime dayalı yapı ulusal sanayiyi üretim konusunda bir merkez haline getirmiştir. Fakat daha ileriye gitmek için yetersiz kalmaktadır. Ortak-girişimler etrafında yer alan yan sanayi firmaları genelde fren, debriyaj, iç-trim parçalar vb. gibi daha geleneksel teknoloji alanlarında ana yetkinliklerini geliştirmişlerdir. Bu kilitlenme (lock-in) durumu daha ileriye gidilmesini

engellemektedir. Tez kapsamında ortak-girişimlerin Türk Otomotiv Sanayi'ndeki teknolojik sofistikasyona etkisi ters-U şeklinde tanımlanmıştır. Bu sonuç; tez kapsamındaki üç ayrı vaka çalışması ile de desteklenmiştir.

Yukarıda özetlenen sorunun nasıl aşılacağı konusunda, tezde yapılan vaka çalışmaları yine değerli ipuçları vermiştir. Buna göre; yerli (sermaye yapısında Türk hissedarların ağırlığı olan ve yabancı firmalar tarafından satın alınmamış olan) büyük firmalar, yerli araç üreticileri ve yerli orjinal parça üreticilerinin sahip oldukları know-how bilgisini paylaşmaya daha yatkın oldukları ve yine bu tür firmaların yan sanayiye daha tasarım yoğun işler verdiği tespit edilmiştir. Bu sayede teknolojik bilgi yayınımının daha fazla gerçekleştiği ve yan sanayi firmalarının Ar-Ge ve tasarım konusunda kabiliyetlerini daha fazla geliştirdiği görülmüştür. Buna ilaveten, tasarım ve mühendislik firmalarının daha çağcıl alanlarda daha sofistike projeler yapabildikleri görülmüştür. Türkiye'nin ihtiyacı olanın firma çeşitlerinin özellikle otomotiv endüstrisinde tasarıma dayalı niş alanlarda son ürün üretebilen otomotiv firmaları ve tasarım ve mühendislik firmaları olduğu tespit edilmiştir. Türkiye'nin bu gibi firma çeşitlerinde 'ulusal şampiyonlar' yaratarak uluslararası karar alma süreçlerinde daha çok yer alması gerektiği ortaya çıkmıştır. İlgili firmaların geliştirilmesi için şimdikinden farklı yeni bir politika yaklaşımı önerilmiştir. Buna göre devlet bu yeni politika yaklaşımında daha proaktif bir rol oynamalıdır (örneğin; Mazzucato 2013'te olduğu gibi). Amaç, Güney Kore'deki Hyundai örneğindeki (Lee ve Lim, 2001) gibi küresel otomotiv endüstrisinin karar alma süreçlerinde daha çok yer alabilecek güçlü firmalar oluşturmaktır. Bu durum, ancak sadece firmaların Ar-Ge projelerini gözlemleyen mevcut destek sistemi yerine firmaların kabiliyet gelişimini izleyen ve ona göre destek sağlayan yeni bir sistem ile başarılabilir. Ayrıca, tasarım ve mühendislik odaklı firmaların yeşerebilmesi ve gelişebilmesi bu kapsamdaki girişimlerin ve girişimciliğin desteklenmesi gerekmektedir.

Yukarıdaki öneriler mevcut firmaların ve mevcut sistemde yer alan firmaların dışlanması anlamına gelmektedir. Tez kapsamında mevcut durumun iyileştirilmesine yönelik öneriler de getirilmiştir. Buna göre; örneğin daha geleneksel teknoloji alanlarına odaklanmış yerli tedarikçilerin ortak-tasarımcı (co-designer) seviyesine

yükseltilebilmesi için yine firmaların kabiliyet gelişimlerini izlemeye dayanan bir destek sistemi geliştirilmelidir. Böylece bu firmaların, hem tedarikte bulundukları firmalarla pazarlık güçleri yükseltilecek, hem de karar alma süreçlerinde daha fazla yer almaları sağlanabilecektir. Ayrıca, ortak-tasarımcı seviyesine erişmeleri sayesinde büyümeleri ve aralarında başarılı olanların büyük tedarikçiler ve 'ulusal şampiyonlar' olması sağlanabilecektir. Mevcut sanayinin oluşturulmasında büyük payı olan ortak-girişimler bir kenarda bırakılmamıştır. Özellikle bu firmaların ana merkezlerden daha fazla pay almalarının yolunun Ar-Ge'ye dayalı 'şerefiye' (royalties) kazanmaları sayesinde gerçekleşebileceği tespit edilmiştir. Buna göre; bu firmalar ana merkezlerden daha fazla tasarım yoğun faaliyetlerde Ar-Ge projesi aldıkça hem katma-değerli üretim yapma olanakları artmakta hem de ana merkez firmalarının nezdinde rating'leri (notları) yükselmektedir. İşte, tez kapsamında önerilen yeni destek yaklaşımı bu gerçeği göz önünde bulundurarak ve yine projedense firma kabiliyetlerini izleme ve değerlendirmeye dayanan yeni destek yaklaşımı ile desteklenmelidir. Ulusal İnovasyon Sistemi'nde yer alan destekler ortak-girişimlerin bu tür şerefiyeler kazanmasını destekleyici şekilde yeniden düzenlenmelidir.

İkinci olarak, tezdeki mikro-seviyedeki bulgular çağcıl teknolojilerde faaliyet gösteren firmaların Ar-Ge süreçlerini, projelerini ve çıktılarını daha sofistike hale getirmeye daha açık olduklarını göstermiştir. Buna ilaveten, tasarım ve mühendislik odaklı firmaların niş alanlarda ve çağcıl teknoloji alanlarında daha fazla proje üretme ve gerçekleştirme eğiliminde oldukları görülmüştür. Bahsedile bu iki firma tipinin geliştirilmesi ve sayılarının çeşitli teşvik yasaları ile arttırılması ulusal otomotiv sanayinin gelişimi için önemli bulunmuştur.

Makro seviyede bakıldığında ise, Türkiye'nin üretim merkezi olma konusunda gerçekleştirdiği başarının Ar-Ge'ye yansımadığı ve bu nedenden dolayı Türkiye'nin otomotivde öndeki ülkeleri yakalayamadığı belirlenmiştir. Ar-Ge çıktıları ve bunların ticarileşmesi büyük ölçüde yurtdışı oyunculara bağımlıdır. Buna ilaveten, ulusal inovasyon sistemindeki bazı önemli eksikliklerin giderilmesi gerekmektedir. Örneğin, bilgi yayınımına dayalı yeni işbirliği ağlarının oluşturulması ve işler hale getirilmesi (AB çerçeve programları, mevcut sektörel şemsiye kuruluşların yapacağı

ortak işbirliğini geliştirmeye yönelik faaliyetler, ABD, Japonya, Almanya vb. gibi otomotivde ileri konumdaki ülkelerle yapılabilecek ortak araştırma çalışmaları vb.), araştırma altyapısında eksikliklerin giderilmesi (rüzgar tüneli test merkezi vb. yapıların kurulması), kalifiye insan gücünün geliştirilmesi (doktoralı çalışan sayısının artırılması, ara eleman açığının giderilmesi vb.), eksik olan ve inovasyon sistemini tamamlayıcı kuruluşların kurulması ve sektörde yaşanan kilitlenme durumunun düzeltilmesi bunlar arasında sayılabilir. Türkiye'de mevcut destek yaklaşımının sanayinin belli bir seviyeye gelmesine yardımcı olduğuna kuşku yoktur. Fakat Türkiye'nin mevcut ihracat başarısı öndekileri yakaladığı anlamına gelmemektedir. Öndekileri yakalamak için devlet tarafından uygulanacak daha 'agresif' politika araçlarına ihtiyaç duyulduğu düşünülmektedir. Bunun için şu ana kadar uygulanmakta olan arz-yanlı politikalar, talep-yanlı politikalarla desteklenmelidir. Ulusal şampiyonların ve büyük firmaların yaratılmasına yönelik daha korumacı politikaların uygulanması da bu kapsamda değerlendirilmelidir.

Sonuç olarak, vaka çalışmalarının bulgularına dayanarak tez kapsamında aşağıdaki beş ana sonuca ulaşılmıştır:

- Otomotiv endüstrisinin küresel ve yerel genel görünümü, yerelde Ar-Ge bağlamında bir teknolojik sofistikasyona ulaşılamadığını göstermektedir. Yerel firmaların küresel araç üreticilerine ve OEM'lere mevcut bağımlılıkları bu konudaki en büyük engeldir.
- Türk Otomotiv Sanayi'nin ortak-girişimlere ve küresel karar alıcılara bağımlı mevcut yapısı üretimde mükemmeliyet ve bazı temel Ar-Ge faaliyetlerini gerçekleştirme kabiliyetlerini kazandırmıştır.
- Fakat vaka çalışmalarında ortaya konan gerçeklere dayanarak Türk Otomotiv Sanayi'nin geldiği nokta, onun ileri teknolojiye dayanan inovatif ürünler üreterek öndekileri yakalamasını sağlamasına yetmemiştir.
- Ortak-girişimlere ve yabancı ortaklara dayanan mevcut yapı otomotiv sanayinin üretimde mükemmeliyet kazanmasını sağlarken, tasarım odaklı Ar-Ge projelerini gerçekleştirmek suretiyle daha ileriye gitmesine engel olmaktadır. Tez kapsamında ortak-girişimlerin ve yabancı ortaklıkların

ulusal düzeyde teknolojik sofistikasyona etkisi ters-U şeklinde betimlenmiş ve bu durum öndekilerinin yakalanamamasını en önemli nedeni olarak gösterilmiştir.

- Yukarıda bahsedilen bağımlılıklar nedeniyle öndekileri yakalama konusunda yaşanan başarısızlık orta-teknoloji tuzağı olarak tanımlanmıştır. Orta-teknoloji tuzağı geriden gelenlerin (genellikle gelişmekte olan ülkeler) orta-yüksek teknolojilerde yaşadığı bir durum olarak betimlenmiştir.

Yukarıda bahsedilen sonuçlar üzerine, özetin gelecek bölümünde Türkiye için bazı politika önerileri geliştirilecektir.

3. Politika önerileri

Bu bölümde üç ana başlık altında politika önerileri gerçekleştirilecektir.

3.1.Otomotiv Sanayi'nin genel görünümüne yönelik politika önerileri

Bir önceki bölümde özetlendiği gibi, Türk Otomotiv Sanayi özellikle Ar-Ge süreçlerinin tasarım ve ticarileştirme süreçlerinde küresel OEM'lere ve son ürün üreticilere yüksek düzeyde bağımlı bulunmuştur. Bu bölümde, Türkiye'yi otomotiv sanayindeki küresel değer zincirinden ve bilgi akışından koparmadan gerçekleştirilebilecek politika önerilerinden bahsedilecektir.

Mevcut durumdaki aktörlerle başlamak gerekirse, özellikle Türk Otomotiv Sanayi'nin omurgasını oluşturan ortak-girişimler için en uygun görülen yol, bağlı oldukları ana merkezlerden daha çok Ar-Ge projesi çekerek mevcut süreçlerde sahip oldukları şerefiyeleri yükseltmektir. Devlet, tematik destekleme araçlarını kullanarak ulusal endüstrinin bu şerefiyelerden daha çok pay almasını sağlayacak politika araçları geliştirmelidir. Ar-Ge Merkezlerinin kurulmasına yönelik destekler yoğunlaştırılmalı, ulusal inovasyon sisteminde eksik görülen parçalar – örneğin, rüzgar tuneli altyapısının kurulması – tamamlanmalı, Türkiye Ar-Ge çalışmaları için daha cazip bir ülke konumuna getirilmelidir. Sadece destek programlarının koşullarına uygun projeleri desteklemeye yönelik mevcut yaklaşım değiştirilmelidir. Yeni yaklaşımda, firmalar odağa konmalı ve onların küresel değer zincirinde takip edilmesine yönelik bir izleme ve destekleme sistemi geliştirilmelidir. Örneğin;

ortak-girişim firmalarının sadece Ar-Ge projesi geliştirilmesine odaklanılmamalıdır. Onun yerine, geliştirilen Ar-Ge projesinin ortak-girişim için ne ifade ettiği üzerinde durulmalı; ortak-girişim firmasını ana merkezi nezdinde üst seviyelere çıkarabilecek ve ona şerefiye sağlayabilecek potansiyeldeki projeler ilave katkılarla desteklenmelidir. Ana merkezlerden temel Ar-Ge'ye yönelik projelerin çekilebilmesi için politika araçlarından 'işaret-verme stratejileri' (signalling strategies – ilerideki teknolojilerin şimdiden desteklenip belli bir kabiliyet oluşturulmasının desteklenmesi) uygulanmalı, Ar-Ge merkezlerinin temel Ar-Ge çalışmaları da yapmak üzere Türkiye'ye çekilmesi için ilave katkılar sağlanmalıdır.

Otomotiv yan sanayi ve tedarikçiler için ise; onları küresel firmaların ortak-tasarımcısı pozisyonuna getirebilecek destekler üzerine yoğunlaşılmalıdır. Bu sayede hem tedarikçilerin sağladıkları katma-değer aratacak, hem de bu firmalar küresel bilgi yayınımından daha fazla yararlanabileceklerdir. Tedarikçilerin desteklenmesi için de yine bugünkünden farklı bir politika yaklaşımı önerilmiştir. Buna göre; tedarikçiler yine proje odaklı değil, kabiliyetlerinin gelişimine bağlı olarak desteklenmelidir. Projelerde sadece Ar-Ge'ye değil; o projenin firma kabiliyetlerinin gelişimine ve firmanın küresel değer zinciri içindeki yerine etkisine dikkat edilmelidir. Firmaları ortak-tasarımcı konumuna getirme potansiyeli olan projeler desteklenmelidir.

Şüphesiz ki, yukarıda önerilen farklı destek yaklaşımı devlet kurumlarında ciddi bir kurumsal değişim ve yenilenme gerektirmektedir. Mevcut yapı sadece proje değerlendirmeye odaklanmıştır. Yeni önerilen yapıda ise, sadece projelerin değerlendirilmesi değil, firmaların durumlarının değerlendirilmesi ve onların mevcut sektörde konumlandırılması da gerekmektedir. Bu tür bir izleme süreci mevcut insan kaynaklarından daha kalifiye uzmanların ve daha karmaşık metodolojilerin geliştirilmesini gerektirmektedir. Devlet kurumlarının mevcut iş yapma şekillerinin ve şartlarının bu işleri yapacak yüksek tecrübeli uzmanları nasıl çekebileceği ayrı bir sorun teşkil etmektedir. Her şeyden önce böyle zor bir kurumsal değişimin gerçekleştirilebilmesi için hükümet nezdinde bir kararlılığın gösterilmesi gerektiği düşünülmektedir.

OEM'ler ve büyük firmalar mevcut teknik bilginin yayınımında ciddi işlevlere sahiptir. Daha önceki bölümlerde de belirtildiği gibi, yerli OEM'lerin yerli tedarikçileri bilgi yayınımı bazında daha çok desteklediği ve bilgi paylaşımına daha açık olduğu görülmüştür. Bu durum bize, yerli OEM'lerin ve büyük firmaların geliştirilmesi ile bilgi yayınımının daha çok gerçekleşeceği sonucunu çağrıştırmıştır. Böylece, daha sofistike Ar-Ge projeleri gerçekleştirilebilecektir. Bu durum, Türkiye'de Türkiye menşeli büyük firmaların – 'ulusal şampiyonların' yaratılmasının bir zaruret olduğunu göstermektedir. Türkiye'de ulusal bir araç üreticisinin yaratılması da son 3-4 senedir süregelen bir tartışmadır. Tez kapsamında edinilen bulgular Türkiye'de yerli firmaların büyütülmesi gerektiği bulgusunu ortaya koymuştur. Yerli araç üreticisi yaratma konusu ise genellikle 'geç bir heves' olarak nitelendirilmektedir. Türkiye için bundan sonra yapılabilecek en mantıklı şey, otomotivde geleceği belirleyecek teknolojilerde (örneğin, elektrikli araç teknolojileri) ve niş ürün alanlarında (örneğin, Karsan V1 New York Taksi projesi) böyle bir öncelik geliştirilmesidir. Tez kapsamında, bu tür firmaların geliştirilmesi için korumacılık tedbirlerinden kaçınılmaması gerektiği ve özellikle, Güney Kore ve Çin'in başarılarını gerçekleştirmesinde korumacılığın önemli rol oynadığı vurgulanmıştır. Ayrıca, böyle bir girişimde mevcut sanayinin potansiyelinin maksimum derecede kullanılabilmesi için ağyapılar ve işbirliklerine önem verilmesi, şemsiye kuruluşlar altında tedarikçi ağlarının kurulması önerilmiştir. Womack ve diğerleri (1990)'da da açıkça gösterildiği gibi Toyota'nın başarısının altındaki en önemli etken çok başarılı ve bilgi üreten tedarikçi ağ yapılarının bulunmasıdır.

Son olarak, mevcut sistemde sadece firmaların mevcut kabiliyetlerine ve sorunlarını çözmeye yönelik projeler önerildiği vurgulanmıştır. Türkiye'de mevcut olmayan çağcıl otomotiv teknolojilerinin geliştirilebilmesi için devletin yönlendirmesine ihtiyaç duyulmaktadır. Bunun için, destek yaklaşımının farklılaşarak firmaları geleceğe yön verecek teknolojilerde çalışmaya itmesi gerekmektedir. İlgili teknoloji alanlarında geliştirilecek projelere, şu andakinden farklı olarak % 100'e varan finansal destek verilmesi ve önceden ödeme yapılması gibi teşvik edici unsurlarla bu tür projelerin cazip hale getirilmesi önerilmiştir.

3.2. Firma stratejisi ve Türkiye için mikro çözümler

Tez kapsamında yapılan vaka çalışmaları, mikro seviyede de önemli bulgular elde edilmesini sağlamıştır. Buna göre, çağcıl teknolojilerde ana yetkinliği bulunan firmalar geleneksel teknolojilerde ana kabiliyeti olan firmalara göre daha sofistike Ar-Ge projesi gerçekleştirmeye daha açıktır. Geleneksel teknolojilere odaklanan firmalar belirli kilitlenme problemleri yaşayabilmekte ve zaten yan sanayi firması olarak sahip oldukları düşük finansman nedeniyle mevcut teknoloji alanlarını değiştirememektedir. Bu bulgu gözetilerek aşağıdaki politika önerileri yapılmıştır.

Çağcıl teknoloji alanlarında ana yetkinlikleri olan firmaların sayısı artırılmalıdır. Geleneksel teknolojilere odaklanmış mevcut firmalarda değişimi sağlamak çok güç olabilir. Bu nedenle devlet, öncelikle uzmanların ve sanayinin geniş katılımı ile Vizyon 2023 Strateji Belgesi'ndekine benzer bir şekilde teknoloji yol haritaları hazırlamalı ve bunun uygulanması için sorumlu bir kurum belirlemelidir. Daha sonra işaret verme stratejileri ve talep-yönlü politika araçları kullanılarak bu yeni alanlardaki projeler ve girişimler desteklenmelidir. Bu yeni alanlarda yer alacak küçük firmaların korumacılık tedbirlerine varabilecek tedbirlerle gelişmesi ve büyümesi sağlanmalıdır (List, 1841). Kamu tedariki bu firmaların geliştirilmesi ve büyütülmesi için kullanılabilecek bir araç olarak değerlendirilmiştir.

Tasarım ve mühendislik odaklı firmaların sayısının artırılması ve büyümesinin sağlanması da yine bu kapsamda değerlendirilebilir. Bu tipolojiye sahip olan firmaların daha sofistike Ar-Ge projeleri ve ürünleri geliştirebildikleri; ayrıca ulusal sanayinin kabiliyetinin gelişimine destek oldukları bulgusuna varılmıştır. bu bağlamda, bu firmaların desteklenmesi önem taşımaktadır. Örneğin, bu firmaların ana ve yan sanayi firmaları ile gerçekleştireceği ortak Ar-Ge projeleri hem bilginin yayınımı hem de Ar-Ge projelerinin sofistikasyonu açısından önemli olduğundan, gerçekleştirecekleri projeler ilave hibelerle desteklenebilir.

3.3. Öndekini yakalama, sıçrama ve Türkiye için makro çözümler

Türkiye'nin öndekileri yakalaması ve sıçrama gerçekleştirebilmesi için önündeki ülkelerden daha hızlı gelişmesi gerekmektedir. Fakat gerçekleştirilen vaka

çalışmalarında, otomotiv endüstrisi için böyle bir bulguya rastlanmamıştır. Özetin bu bölümünde bunun nasıl gerçekleştirilebileceği üzerinde durulacaktır.

Öndekini yakalama bağlamında, Türkiye'nin mevcut bağımlılığını aşabilmesi için yukarıda da belirtilen bazı politika önerileri geliştirilmiştir. Politika önerilerinde korumacılık tedbirleri vurgusu dikkat çekmektedir. Fakat bu vurgu Türkiye'nin kesinlikle içe kapanması anlamına gelmemektedir. Bilakis, otomotiv sektöründe ayakta kalabilmek için küresel otomotiv endüstrisinden ayrı kalmak düşünülemez. Fakat bu endüstride söz sahibi olabilecek araçlara ihtiyaç duyulmaktadır. Ayrıca, bu araçlardan biri de özellikle yabancı yatırımların Türkiye'de kuracakları Ar-Ge merkezleri, mühendislik ve tasarım firmaları ve yeni üretim merkezleridir. Türkiye Ar-Ge'ye yönelik doğrudan yabancı yatırımı çekebilecek ulusal inovasyon sistemine ve yatırım ortamına sahip olmalıdır. burada dikkat edilmesi gereken en önemli husus tasarım yoğun Ar-Ge süreçlerinin ülkeye çekilmesi ve buradan sağlanacak bilgi yayınımı ile dışarıya bağımlılığın azaltılması olmalıdır.

Endüstride sıçrama süreçlerinin bir ülke sanayi tarafından başarılması ise daha karmaşık ve zor politika tasarımlarını ve bunların etkin bir şekilde uygulanmasını gerektirmektedir. Şüphesiz ki, bu durum aktif bir devlet müdahalesini de beraberinde getirmektedir. Sıçrama süreçlerinin gerçekleştirilmesi için ilerideki ülkelerle aradaki boşluğun doldurulması bir diğer gereksinimdir. Bu boşluğun doldurulması ise, daha sofistike Ar-ge ve inovasyon süreçleri ve ürünleri ile gerçekleşebilmektedir. Ulusal inovasyon sistemindeki eksikliklerin tamamlanması bir diğer gereksinim olarak karşımıza çıkmaktadır. Bütün bunların yapılabilmesi ciddi bir kurumsal değişim anlamına gelmektedir. Örneğin, yukarıda özetlendiği şekilde Türkiye destek yaklaşımını daha proaktif bir şekle getirecek yeni devlet kurumlarına ihtiyaç duymaktadır. Sanayinin bilişsel ve fiziki yapısını değiştirebilecek politikalara ihtiyaç vardır. Talep yönlü politikalar, firma izleme sistemlerinin kurulması ve buna göre destek dağıtılması, devletin geliştirilecek teknolojilerde aktif yönlendirmesi, korumacılık tedbirleri ile sanayi yapısının daha çağcıl otomotiv teknolojilerine dayandırılması yönetilmesi daha zor süreçleri kapsamaktadır. Mevcut firmaların büyütülmesi, yeni firmaların bu firmalara eklenmesi, ulusal şampiyonlar ve markalar yaratılması gibi politika önerilerinin

gerçekleştirilmesi ile Türkiye Ar-Ge süreçlerinde dışa bağımlılığını azaltacak ve küresel otomotiv sanayinde söz sahibi olabilecektir. Ancak bu sayede etkin bir sıçrama süreci gerçekleşebilecektir.

4. Sonuçlar ve Tartışma

Bu tezde, kantitatif ve kalitatif yöntemler kullanılarak, Türkiye'nin otomotiv endüstrisinde öndekileri yakalama performansı gösteremediği ortaya konmuştur. Türkiye'deki mevcut sanayi yapısı Ar-Ge ve ticarileştirme süreçlerinde küresel karar vericilere ciddi bir bağımlılık arz etmektedir. Özellikle 1990'dan sonra gerçekleştirilen başarılı öğrenme sürecine ve üretimede ulaşılan kalite ve mükemmeliyete rağmen aynı başarı Ar-Ge süreçlerine ve çıktılarına sirayet etmemiş ve Türkiye önündeki ülkeleri yakalayamamıştır.

Bu sonuç bizi Türkiye'nin konumunu 'orta-teknoloji tuzağında' olarak betimlemeye yönlendirmiştir. Buna göre; 'orta teknoloji tuzağı' bir ülkenin orta veya orta-üst teknolojiye dayanan bir endüstri kolunda, küresel oyuncular tarafından kurulmuş düzene bağımlılığını kendi elle tutulur ya da elle tutulmayan varlıkları ile kıramadığı, o endüstrinin daha geleneksel teknolojilerine kilitlendiği ve Ar-Ge, inovasyon ve teknolojide kendisini daha fazla geliştiremediği bir durum olarak tanımlanabilir.

Bu argüman, yapılan vaka çalışmalarının bulguları ile desteklenmiştir. Buna göre, Türkiye Ar-Ge ve inovasyon alanında daha sofistike projeler geliştirmekte zorlanmakta; bu durum ülkenin otomotivde daha ileri gitmesini engellemektedir. Bu durum, Türkiye'nin orta-gelir tuzağında olması ile de ilintilendirilebilir.

Türkiye otomotiv sektöründeki serüvenine 1960'lı senelerde neredeyse sıfırdan ithal ikameci politikalarla başlamıştır. İthal ikameci politikalar sayesinde alınan lisanslar altında Türkiye'de otomotiv montaj sanayi gelişmiş; buna bağlı olarak yan sanayiler kurulmaya başlanmıştır. 1980'li senelerde ihracat odaklı büyüme politikası sayesinde Türkiye kalite ve rekabetçilik gibi kavramlarla tanışmıştır. türk Otomotiv Sanayi de bu yeni gelişmelerden nasibini almış; ve daha kaliteli ve rekabetçi ürünlerin nasıl üretilebileceğine yönelik sorgulamalar ortaya çıkmıştır. 1990'lı yıllar

sanayinin Ar-Ge kavramı ile tanıştığı yılları göstermektedir. Ar-Ge ve inovasyon rekabetçiliğin ana etkeni olarak görülmeye başlanmış; ilk Ar-Ge destekleri de bu senelerde verilmiştir. 2000'li yıllarda Türk Otomotiv Sanayi'nde Ar-Ge farkındalığı ve Ar-Ge proje sayısı artarken üretim de kaliteli hale gelmeye başlamıştır. Yan sanayinin oluşumu da kritik bir eşiğe ulaşmıştır. 2010 senesine gelindiğinde Türkiye Ar-Ge, inovasyon ve rekabetçilik kavramlarına alışmış; sanayiye devlet tarafından birçok farklı Ar-Ge programı altında destekler verilmiştir. 2010 senesi itibariyle Türkiye kaliteli üretimiyle bir üretim mükemmeliyet merkezi haline gelmiştir. Fakat özet boyunca belirtilen nedenler dolayısıyla Türk Otomotiv Sanayi'nde Ar-Ge için aynı şeylerden bahsedilememektedir. Dışa bağımlılık, yaygın ortak-girişim yapısı, sistemik problemler, geleneksel teknolojilere kilitlenme problemi ve politika yaklaşımının değiştirilememesi ve yenilenememesi vb. gibi etkenler Türkiye'yi orta-teknoloji tuzağına sürüklemiştir.

Türkiye'nin orta-teknoloji tuzağından kurtulabilmesi için yeni bir politika yaklaşımına ihtiyacı bulunmaktadır. Bu çerçevede, otomotiv sektörünün geleceğine yön verecek teknolojilerde söz sahibi olabilmek için işaret-verici politika araçları ve talep-yünlü politika araçlarının uygulanması şiddetle tavsiye edilmiştir. Kamu tedariğine dayanan talep-yünlü politikalarla Türkiye elektrikli araçlar, araçları hafifletecek ileri malzeme teknolojileri, sistem tasarımı vb. gibi çağcıl alanlarda ana yetkinliklerini geliştirmiş firmalar yaratabilecektir. Bu firmaların niş alanlarda ürünler vermesi ve bunları başarı ile ticarileştirmesi Türkiye'nin otomotivdeki gelişimini hızlandıracaktır. Ayrıca bu alanlarda çalışan ve üreten belli bir insan gücü ve entelektüel sermayenin oluşumunu sağlayacaktır. bu tür projeler ve firmalar farklı bir destek yaklaşımı ile, yaşayacakları finansal problemleri de düşünerek projede harcama yapılmadan önceden gerekli bütçe aktarılarak desteklenmelidir. Yine bu durum da farklı bir politika yaklaşımını gerektirmektedir. İşaret-verici politika araçları yine temel Ar-Ge'ye dayanan projelerde uygulanmalı ve otomotivde geleceğin teknolojilerinin önceden çalışılması sağlanmalıdır.

Yabancı karar alıcılara, OEM'lere ve araç üreticilerine bağımlılığın ise ulusal şampiyonlar ve niş alanlarda ulusal markaların yaratılması ile azaltılması önerilmiştir. Bu şekilde, küresel karar alma süreçlerinde daha etkin rol alınabileceği

düşünülmüştür. Bu tür firmaların yaratılabilmesi için korumacılık tedbirlerini de içerecek yeni bir politika yaklaşımı önerilmiştir. Buna göre, mevcut destek sisteminde sürekli benzer projelerin desteklenmesi yerine firmaların uygun Ar-Ge projeleri ile ana yetkinliklerinin gelişmesini izlemeye dayanan yeni bir destek yaklaşımı tavsiye edilmektedir. Firmalar ancak kabiliyetlerinin gelişimi devam ettikçe ve küresel sanayide daha üst konulara çıkma potansiyeli yaratabilecek projeleri ile desteklenmelidir. Örneğin, tedarikçiler için ortak-tasarımcı olmalarını sağlayabilecek projeler destek kapsamında değerlendirilmelidir. Ya da ortak-girişim firmalarının ana merkezlerinden şerefiye payı alabilecekleri sofistikasyondaki projeleri desteklenmelidir. Çağcıl teknolojilerde ana yetkinliklerini oluşturacak yeni kurulmuş firmalar ise, korumacılık tedbirleri ile küresel rekabete hazırlanmalıdır. Bu firmaların gelişiminin takibi de yine uygun metodolojilerin geliştirilmesi ve izleme sisteminin kurulması ile yapılmalıdır. Bir önemli nokta, daha önce belirtildiği gibi korumacılık tedbirlerinin uygulanması Türkiye'yi serbest-ticarete kapatmak anlamına gelmemektedir. Türkiye küresel otomotiv endüstrisi içinde bulunmalı ve buradan bilgi ve sermaye akşını sağlamaya devam etmelidir. Ar-Ge odaklı doğrudan yabancı yatırımlar bunun için önemi bir araç olarak gözükmektedir. Bu yatırımların devlet tarafından doğru yönlendirilmesi, Türkiye'nin Ar-ge kapasitesinin gelişmesine yardımcı olacaktır. Fakat dikkat edilmesi gereken husus, yabancı yatırımlar tarafından gerçekleştirilecek Ar-Ge'nin Türkiye'nin bağımlılığını pekiştirmekten ziyade Türkiye'nin yetkinliklerini geliştirmeye odaklanacak şekilde yönlendirilmesidir. Bunlara ilaveten, Türkiye'de inovasyon sistemindeki problemler çözülmeli, tamamlayıcı yeni kurumlar kurulmalı, altyapı ve insan kaynağına yatırımlar hızlandırılmalıdır. Özet boyunca önerilen yeni politika yaklaşımı ciddi bir kurumsal değişim ve dönüşüm gerektirmektedir. Devletin belki de yeni kuracağı kurumlar aracılığıyla bu değişimi gerçekleştirmesi gerekebilecektir. Firmanın kabiliyet gelişiminin izlenebilmesi için yeni metodolojiler geliştirilmesi, bu metodolojileri uygulayacak yüksek tecrübede ve bilgi seviyesinde uzmanların devlette çalışmaya ikna edilebileceği yeni çalışma koşullarının yaratılması ve en önemlisi de devletin mevcut bilişsel yapısının daha esnek hale getirilerek değiştirilmesi ciddi zorluklar olarak ön plana çıkmaktadır. Bu değişimin ancak hükümetin bu farklı politik yaklaşımı sahiplenmesi ile olabileceği düşünülmektedir.

Türkiye otomotiv sanayinde orta-teknoloji tuzağını aşamaması durumunda artan ücretlerle birlikte emek-yoğun mevcut sanayiyi kaybetme riski ile karşılaşabilir. Bu riskin azaltılabilmesi için yukarıda özetlenen politikaların bir an önce tasarlanıp hayata geçirilmesi gerekmektedir. Gelecek yıllar otomotiv sanayi için yeni fırsatlar kadar yeni tehditleri de beraberinde getirme olasılığını taşımaktadır.

Bu tez kapsamında yapılan çalışmalar farklı ülke örnekleri ile zenginleştirilip orta-teknoloji tuzağı kavramı daha sağlam temellere oturtulabilir. Ayrıca, orta-teknoloji tuzağının orta-gelir tuzağı yaşayan ülkelerin durumunu açıklamakta da faydalı olabileceği ve bu yönde araştırmalar yapılabileceği de değerlendirilmektedir.

Sonuç olarak, bu tez kapsamında Türk Otomotiv Sanayi'nin durumu hakkında farklı bir analiz yapıldığı düşünülmektedir. Politika yapıcılara ve otomotiv sanayi temsilcilerine faydalı öneriler getirilmiştir. Vaka çalışmalarında kullanılan metodolojiler ve ortaya atılan kavramların literatüre önemli bir katkı sağlaması temenni edilmektedir.

Appendix G: Tez Fotokopisi İzin Formu

TEZ FOTOKOPİSİ İZİN FORMU

ENSTİTÜ

Fen Bilimleri Enstitüsü ☐

Sosyal Bilimler Enstitüsü ■

Uygulamalı Matematik Enstitüsü ☐

Enformatik Enstitüsü ☐

Deniz Bilimleri Enstitüsü ☐

YAZARIN

Soyadı : Bürken
Adı : Serkan
Bölümü : Bilim ve Teknoloji Politikası Çalışmaları

TEZİN ADI (İngilizce) : Technology Development in Turkish Automotive Industry: A Case of Middle-Technology Trap

TEZİN TÜRÜ : Yüksek Lisans ☐ Doktora ■

1. Tezimin tamamından kaynak gösterilmek şartıyla fotokopi alınabilir. ■
2. Tezimin içindekiler sayfası, özet, indeks sayfalarından ve/veya bir bölümünden kaynak gösterilmek şartıyla fotokopi alınabilir. ☐
3. Tezimden bir bir (1) yıl süreyle fotokopi alınamaz. ☐

TEZİN KÜTÜPHANEYE TESLİM TARİHİ: