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Mehmet Teoman Pamukçu

Alper Sönmez

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

Technology Transfer in the Global AutomotiveValue Chain. Lessons from the Turkish Automotive Industry*

Mehmet Teoman PAMUKÇU [1]
Alper Sönmez[2]

[1]Department of Science and Technology Policy Studies, Graduate School of Social Sciences, Middle East Technical University, MM Building, No: 220, 06531, Ankara, Turkey; Email: pamukcu@metu.edu.tr Phone: +90-312-2103719; Fax: +90-312-2107993.
[2] Department of Economics, Middle East Technical University, 06531, Ankara, Turkey; Email: salper@metu.edu.tr Phone: +90-312-2103077; Fax: +90-312-2107957. Visiting Fellow, Applied Economics and Management, Cornell University, NY, USA, Email: alpersonmez@cornell.edu.

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1. Introduction

The acceleration of the globalization of the world economy in the new millennium makes all the more important industrial upgrading and acquisition of advanced technological capabilities by nations in order to enhance competitiveness of their economies on world markets and improve welfare of their populations. The main characteristics of the globalization era can be summarized as follows: an accelerated pace and changing nature of technological change -materialized in the emergence and rapid diffusion of new technologies-, liberalization of the world economy under the auspices of WTO, an ever increasing role of Multinational Companies (MNCs) in the world economy through their increased implications in Foreign Direct Investment (FDI) flows and global value chains and finally, the enabling effect of the intense use of ICTs which has the major outcome of reducing geographical distances. While some researchers point to the opportunities the globalization process provide to developing nations, others stress on the contrary the threats associated with it, especially a wider technological and income gap between developed and developing nations, and a risk of marginalization of the least developed ones[3].

One topic that is intensively debated among scholars concerns the implications of the enhanced role of MNCs in the world economy as far as the industrial upgrading and related technological catch-up processes in developing nations are concerned. Indeed, even today only a limited number of developed countries control the conception, development and production of new technologies in the world. At least until recently, technological activities of MNCs were pointed out as being the least globalized activity of MNCs[4]. An implication is that modern technologies available on the world market reflect the characteristics of the economies and innovation systems of developed nations, including complexity of technological knowledge embodied in high capital intensity hardware (machinery, parts and components), peculiar preferences of high-income consumers, advanced level of technological capabilities of private companies and finally solid linkages built amongst actors involved in the innovation process thanks to a developed national system of innovation[5]. Although developing nations do not benefit directly from the such advantages, they can attempt to access some of the proprietary intangible assets possessed by MNCs[6], at least indirectly through technology transfer[7].

FDI by MNCs is currently considered to be a major channel for developing countries in order to access the advanced technologies of the developed world. Indeed, the ever increasing complexity of new technologies, the increased number of interacting components they incorporate, the more stringent IPR regulations under the TRIPS umbrella and the unwillingness of foreign firms -mainly MNCs- to transfer their technologies to developing nations through licensing, all these factors made

[3] On opportunities and threats, see Perez and Soete (1988), Dore (1989) Freeman (1989), Kaplinsky (1989) and Shin (1996).
[4] Patel and Pavitt (1991).
[5] For a seminal book stressing these characteristics and their implications for developing countries, see Stewart (1977).
[6] These assets may concern the following domains: production/process technologies, organization, manufacturing, marketing, sales, and distribution.
[7] This is all the more realistic since almost all of present day developed nations benefited in the past from transferring advanced technologies in the course of their industrialization processes: see Tanaka et al. (2007).

the once often used modes of technology transfer - reverse engineering, imitation and learning-by-doing based on imports of machinery- inefficient in the globalization era. In case domestic firms in developing countries can enter directly in contact with the affiliates of MNCs, this may mitigate to a certain extent these problems since a mutually beneficial relationship between the two parties may persuade the foreign affiliate to share part of its technological knowledge base with the domestic partner. This mode of technology transfer remains only a possibility and requires many factors to coexist not only to occur but also to impact positively on the production and technological capabilities of domestic firms.

A number of empirical studies using quantitative as well as qualitative research methodologies addressed the issue of whether technology transfers from MNC affiliates to domestic firms occur in developing nations and if so, through which channels and under which conditions[8]. Their findings point to the importance of the absorptive capacity of firms, the level of physical and human infrastructure in the country, the degree of competition at the sector level as well as the technology gap existing between foreign and local enterprises. Furthermore, one major lesson of these studies is that the likelihood of knowledge transfers increases significantly when enterprises operating in vertically-linked industries, rather than those operating in the same sector[9], are involved in the technology transfer. Indeed, deliberate linkages formed between domestic and foreign firms operating in sectors characterized by intense backward or forward linkages are much more promising for knowledge transfers than spillovers occurring between competitors in a given sector.

The high potential rewards of technology transfers between MNC affiliates and domestic firms operating in vertically-integrated sectors motivated a number of case studies on linkage formation between foreign manufacturers and their suppliers in the electronics and automotive sectors in a number of developing countries[10]. These studies provide us with important insights about the existence, extent and nature of knowledge-enhancing relationships between domestic suppliers and their foreign customers in developing countries.

An increasing number of studies focus on buyer-suppliers relationships in the automotive industry in various countries since the rapid pace of technological change, the extent of the globalization process and the intensified international competition are taking place more intensively in this sector than in any other one[11]. Indeed, partly in response to the intensified competition they faced from Asian automotive manufacturers, many US and European MNCs delocalized their manufacturing activities to emerging economies from 1980s onward and gradually increased their presence on these markets. This period coincided with the reconsolidation of the automotive industry, which led to a drastic fall in the number of producers through mergers, acquisitions or simply by exiting the

[8] For a seminal paper on the costs and problems associated with intra-MNC technology transfer, i.e. from parent company to its affiliates located abroad, see Teece (1977). For developing countries, see the articles that appeared in a special issue of European Journal of Development Research in 2004. See also Eden et al. (1996), Blomstrom and Kokko (1998), Borensztein et al. (1998), Greenaway and Gorg (2004), Saggi (2005) and Smeets (2008).

[9] In other terms, we are persuaded that the technology transfer potential of *intra-industry* or *horizontal* FDI-related knowledge spillovers is much less than those associates with *inter-industry* or *vertical* spillovers. On this issue, see Javorcik (2005) and Saggi (2005).

[10] See Techakanont (2002) on the automotive industry in Thailand, Giroud (2003) on the electronics sector in Malaysia, Berger (2005) on Thailand, Ekmekci (2009) on the automotive sector in Turkey and Saliola and Zanfei (2009) on the manufacturing sector in Thailand. See also UNCTAD (2001).

[11] Dicken (2007).

market. This context had major implications for the buyer-supplier relationships in the automotive industry which were restructured during this period, mainly as a result of the desire of manufacturers to cut down costs by focusing on their core competencies.

Three major transformations exerted a fundamental impact on buyer-supplier relationships in the automotive industry. First, many suppliers were granted the responsibility to design entire products on their own. Second, supply of complete system components or products (modules) rather than supply of individual parts were required from suppliers and third, as a result buyers became much more involved with their suppliers in order to increase the quality of their products, reduce defect rates and ensure timely delivery of inputs to be used in the production process so as to minimize problems on the production line[12]. This process was accompanied by the emergence of various groups of suppliers possessing very different design and manufacturing capabilities and led manufacturers to impose stringent criteria[13] for a supplier to work closely with them and finally become -and remain - their "direct supplier". These transformations in buyer-supplier relationships, due to the existence of mutual interests between the two parties, made auto manufacturers more willing to transfer part of their knowledge about manufacturing, design and R&D activities to their direct suppliers. These transfers occurred under different forms, involved knowledge and technology flows of different quality and quantity and impacted differently on the competencies of suppliers. A host of factors including absorptive capacity of suppliers, their production capabilities, ownership structure, degree of proximity to automotive manufacturers, the type of components they produced and governance relations in supply chains impacted on the outcome. Hence, similar to intra-industry FDI-related knowledge spillovers, spillovers accruing through backward linkages do not occur automatically and studies should to be conducted in order to identify those factors that influence their occurrence.

Our objective in this paper is to analyze aforementioned issues for the automotive sector in Turkey through a survey conducted among suppliers of parts and components in the year 2010. MNCs started investing in the automotive sector in Turkey in the late 1960s and increased significantly their presence since the 1990s. This sector has contributed positively to economic growth, employment creation and to export performance and is therefore considered as one of the most strategic industries in the Turkey. Moreover, automotive manufacturers, mostly joint ventures formed by foreign and domestic agents, have acquired extensive production capabilities over time and transformed Turkey into a production platform for several MNCs, as indicated by the evolution of Turkey's position amongst world producers[14] (see next section). However, the aforementioned consolidation process of the world automotive industry led automotive manufacturers in Turkey to go one step ahead and attempt to transform her from being solely a production base for majority-owned MNCs towards a design and R&D platform[15]. Efforts in this direction by manufacturers –fully or partly owned affiliates of MNCs– will depend strongly on the capacity of suppliers to play their

[12] Humphrey and Memedovic (2003).

[13] Concerning mainly quality improvement, reduction in defect rates, ensuring on-time delivery and cost reduction on a continuous basis.

[14] This development has had significant effects on the emergence of automotive suppliers in Turkey as well as on the acquisition of manufacturing and design capabilities by them. See Bedir (1999) and Wasti et al. (2006).

[15] SPO (2005).

role by carrying out a number of design-related activities previously conducted by manufacturers. This, in turn, will depend on whether automotive manufacturers are ready to transfer knowledge and technology to their suppliers and also on the extent, nature and modalities of these transfers. To analyze this question, we prepared a questionnaire and used it to collect detailed data and information from auto suppliers present in Turkey. The survey was conducted with the CEOs, R&D, production and product directors of 165 supplier firms in order to investigate the existence, nature and extent of technology transfers from buyers to suppliers.

The remainder of this paper is organized as follows. Section 2 presents an overview of the evolution of the automotive industry in Turkey. In section 3 we discuss the research methodology used and characteristics of the data collection process. In Section 4, first the profile of suppliers in our sample is examined, then knowledge and technology transfers (KTTs in the sequel) accruing from MNCs to their suppliers are analyzed, and finally determinants of various modes of KTTs are analyzed through ordinal logistic regression models. We conclude our study in Section 5.

2. Automotive industry in Turkey and changing producer-supplier relationships

Automotive industry in Turkey dates from the mid-1950s when it was established as an assembly industry. A number of MNCs formed majority owned joint ventures with Turkish partners and entered into the market in the late 1960s. Until the 1980s, the share of the automotive industry in Turkey's total exports was almost nil due to the import substitution development strategy pursued until the year 1980. Following a switch to much-more outward oriented economic policies in 1980, the share of automotive products in exports started to increase and reached 1% on average for 1980-1990. After the signature of the Customs Union agreement between Turkey and the EU in 1996, which eliminated custom duties levied on industrial products, three additional global automotive manufacturers from Japan and South Korea launched production in Turkey. Figure 2.1 shows that the share of automotive products in total exports continued to rise continually from 2000 onwards and is now only second behind textile products with a share of 13% in 2009. Turkish automotive industry has experienced significant output and productivity growth during the last decade and enhanced its competitiveness on global markets, which helped transforming it into one of the most dynamic and important sectors in Turkey[16].

Figure 2.1: Evolution of sector shares in TOTAL exports in Turkey: 1970-2009 (%)
(Insert here)

Note that policies implemented since the early 1980s to open up Turkish economy were not enough initially to increase the inflow of FDI. Until the year 2000, annual FDI flows to Turkey were rather low

[16] See SPO (2005) for more information about the automotive sector in Turkey.

(below US$ 1 billion) compared to other emerging economies (UNCTAD, 2005). Total *cumulative* net FDI inflows attained US$ 9.7 billion between 1974 and 1999, corresponding to an annual average of US$ 370 million. As presented in Figure 2.1, there has been an important increase in the FDI flows from 2000 onwards (annual average of US$ 9 billion between 2000 and 2008) especially after the Turkish government has started to liberalize its investment policy and proceed with privatizations of its assets in the economy. As illustrated in Figure 2.2, FDI inflows peaked in 2007.

Figure 2.2: Net FDI inflows in Turkey over 1999-2008 (million dollars)
(insert here)

Figure 2.3 presents a number of indicators about foreign presence in a number of manufacturing industries over the period 2003-2006. They measure the share of foreign firms in the total number of firms, in total employment, in production and in value added at the two-digit NACE level. The sector with the most important foreign presence is the automotive sector (NACE 34): foreign firms constitute 17% of all firms and employ nearly 55% of total labor, produce almost 80% of the gross output and 73% of the value added. Next come the electrical machinery sector (NACE 31) and the radio, television and communication sector (NACE 32). The major place occupied by MNC affiliates in the automotive sector points to possible flows of KTT accruing from buyers to suppliers in this sector.

Figure 2.3.: Share of foreign firms in production, value added, employment and total number of firms over 2003-2006 (%)
(insert here)

Figure 2.4 shows the share of Turkey's motor vehicle production in world total production for cars and commercial vehicles categories over the period 1999-2010. In terms of number of units produced, Turkey was ranked 24th in world with total amount of nearly 300,000 vehicle production (222,000 cars and 76,000 commercial) corresponding to a total share of ‰5 in 1999. Moreover, Turkey was ranked 10th among European countries for the same year. In the last decade, Turkey managed to triple her share (15‰) and rose to 16th place with nearly 1.1 million units produced (600,000 cars and 490,000 commercial vehicles) in 2010. Turkey is now the 5th largest producer among European countries after Germany, Spain, France and UK, respectively. Besides, Turkey's share has risen to a larger extent in commercial vehicles than in cars. In the world ranking, Turkey is at the 9th position in car production and 17th rank in commercial vehicles production with the shares being equal to 1% and 2.5% respectively in 2010.

Figure 2.4: Share of Turkey's Motor Vehicle Production in World Production (‰)
(insert here)

Data presented above point to the remarkable performance of the Turkish automotive industry at least since the 1990s. However, such a performance will be very difficult to sustain following the

increase in the number of competitors on the world market and the emergence of new low-cost locations to which MNCs will certainly be attracted. Therefore, if Turkey wants its automotive industry to continue to be a major engine of economic growth and important source of employment creation, she will have to upgrade it from being solely a production platform to an excellence center providing high-quality services in terms of R&D, design and innovation. The role of KTTs and collaboration activities with MNCs, undoubtedly, will play an important role in this transition.

3. Data and research methodology

No ready-made dataset is available to investigate KTT-related issues examined in section 2 for the Turkish economy. Two research methods can be used to collect the data and information required for our analysis and each of them involves dealing, to a different degree, with a selected sample of supplier firms operating in the Turkish automotive sector. The first one involves conducting in depth semi-structured interviews with a selected sample of firms while the second one aims at collecting data through a survey questionnaire to be filled in by the respondents. Each method has its advantages and shortcomings but the second one will be adopted here since it will enable us to conduct an econometric exercise in the next section in order to examine determinants of KTTs in Turkey. Indeed, by its nature, the first method –case study research– is applicable only to a limited number of firms, and although it may bring valuable information about the issues analyzed, it is not suitable for quantitative analysis[17].

We proceeded in the following manner in order to determine the target population to be analyzed in our study.

First, we examined the list of members of the Association of Automotive Parts and Components of Turkey (TAYSAD)[18], which is the most important representative body of automotive supplier firms in Turkey. In 2010, this association had 286 members which are responsible for 65% of total production of this sector[19] and 70% of its exports. At the same time, 29 affiliated companies are among the Top 500 industrial companies list compiled each year by the Istanbul Chamber of Industry whereas 41 members are among the Top 1000 exporters in Turkey. Moreover, among the 286 firms affiliated with TAYSAD 58 (20 %) have foreign partners. Therefore, an analysis based on TAYSAD members will enable us to carry out an analysis distinguishing between local and foreign firms operating in the part and components sector in Turkey, which is seldom done in studies concerning automotive suppliers in Turkey.

Note that TAYSAD members are in general *direct suppliers* of the automotive manufacturer companies operating in Turkey. By "direct supplier", we refer to first-tier suppliers that work directly with automotive manufacturers and produce systems, modules or other non-trivial parts and

[17] Ekmekci (2009) uses the first method – case study – to analyze knowledge and technology transfer in the Turkish automotive industry.
[18] More information on TAYSAD is available at http://www.taysad.org.tr .
[19] Parts and components subsector is denoted as NACE 343 according to the NACE (Rev 1.1.) nomenclature. On the other hand, the automotive manufacturing subsector is NACE 341.

components. In contrast, the second- and third-tier suppliers do not produce directly for manufacturers but for first-tier suppliers and their products are technologically simple commodity-type parts and components. Hence, by using information and data on TAYSAD members, we will focus in this paper on the relatively most developed suppliers in the NACE 343 sector. Indeed, data collected by the Turkish Institute of Statistics (TurkStat) indicate that there are 2525 firms operating in this sector by the year 2008[20]. Therefore, our target population comprises about 10 % of the whole population of automotive suppliers in Turkey. It must be pointed out here that focusing on such a limited number of firms does not affect negatively the quality of our research for several reasons. Indeed, most of the remaining 90% suppliers are non-incorporated micro firms (i.e. with less than 10 employees) which do not conduct any R&D or innovation activity, possess extremely poor production capabilities, have no direct links with the foreign MNCs operating in the automotive sector and therefore are not suitable for the analysis carried out in this paper. Moreover, although being part of the NACE 343 sector, many of these micro firms sell more than half of their products to sectors other than the automotive sector. Therefore, we are convinced that those firms with an absorptive capacity more open to knowledge and technology transfer are to be found among the firms associated with TAYSAD[21].

Second, information on the geographical distribution of TAYSAD firms indicates that most of them are located in the cities of Bursa, Istanbul, Kocaeli at the Marmara region and in Izmir at the Aegean region. TAYSAD provided us with the names and addresses of 219 affiliated companies operating in these four cities. However, some of them refused to take part to the survey and others indicated that their main activity was not anymore supply of part and components to automotive manufacturers. Therefore, an additional data source was required to compensate for the reduction occurring in the sample size. The lists of firms affiliated with Bursa Chamber of Trade and Industry and with several organized industrial districts were checked to identify those automotive suppliers which are not members of TAYSAD. Finally, another 82 supplier firms were identified and added to the initial list, and we ended up with a sample frame including 290 firms.

Finally, a contract was signed with a private research firm in order to carry out the survey with these 290 supplier firms. However, some firms declared they did not operate anymore in the automotive sector and others refused to take part to the survey, and we are left with a sample of 158 firms who completed the survey questionnaire. With data collected from 7 firms during a pilot survey conducted to test the survey questionnaire, we have finally a sample of 165 firms, indicating a response rate of 57 %. The survey was administered to the CEOs, R&D, production and product directors of supplier firms.

Our survey questionnaire comprises eight main sections, each dealing with a different aspect of the KTT process[22]:

[20] See www.tuik.og.tr. Note that data for the years 2009 and 2010 were not yet published by TurkStat in 2011.
[21] Other studies investigating this issue opt for a similar method in order to select the sample frame: see Bedir (1999), Tuncel and Olmezogullari (2011), and Wasti et al. (2006). This, by no means, implies that industrial and innovations policies should not be designed specifically for these micro firms – mostly second- and third-tier suppliers-, quite the contrary. This issue is, however, beyond the scope of this paper.
[22] More details on the items included in each section will be provided later in the text.

1. General information on the characteristics of suppliers
2. Information on knowledge and technology transfers (related to product and production process), financial assistance and training assistance from buyers to their suppliers
3. Market structure of suppliers
4. Production, technological and design capabilities of suppliers
5. Input sources of suppliers
6. Collaboration of customer firms[23] with their suppliers
7. R&D and innovations activities of suppliers
8. Factors in the evolution of the performance of suppliers

Besides variables measured in monetary terms, responses were provided to the survey questionnaire in the form of binary variables (yes/no) and ordinal variables measuring the strength of the answer on a five point Likert scale. The nature of variables used will determine the type of econometric estimation techniques used in this paper.

4. Knowledge and technology transfers from customers to suppliers in the Turkish automotive industry

In this chapter we will first conduct a non-quantitative/interpretative analysis of the data collected through our survey. Second, based on the variables constructed from raw data, we will attempt to analyze determinants of knowledge and technology transfers with appropriate econometric techniques.

4.1 Main characteristics of suppliers[24]

Table 4.1a below contains summary statistics on a number of key variables constructed from data survey questionnaire. Three groups of firms are distinguished therein: local firms, foreign firms, and direct supplier firms – a final column concerns all the firms included in the sample[25]. This distinction will be maintained in all the tables that will be analyzed in this section. It will enable us to test for the significance of the equality of the mean of different variables between local *versus* foreign firms as well as between direct suppliers *versus* non direct suppliers firms[26]. Depending on the type of variable (continuous, categorical or ordinal) and on the number of observations available, different

[23] The two terms "buyers" and "customers or customer firms" will be used interchangeably in the sequel.
[24] Data pertaining to the number of employees, sales, export share in sales and R&D expenditures refer to the year 2008.
[25] For the definition of local and foreign firms, see Table 4.2.
[26] In order to save space, data on non-direct suppliers will not be presented in the tables.

statistical tests will be carried over. Data presented in Table 4.1a aims at providing an insight to the reader about the main characteristics of our sample

Table 4.1a: Summary statistics
(insert here)

Large average firm-size, measured by the number of employees or by total sales, confirms our expectations that a large majority of firms in the sample are direct suppliers of the automotive manufacturers –i.e. first or second tier suppliers. Moreover, foreign firms are larger than domestic firms, and they are also younger –most of them were established after year of 2000. On average, foreign suppliers are more export-orientated, spend more on R&D activities and are also more R&D intensive than local firms. However, local firms seem to have, on average, more patents – grants or applications –than foreign firms. When we look at the last two indicators concerning the duration of the work for the most important customer (*worktogether*) and the share of subcontracting agreement in total (*subcontracting*), local suppliers are better placed than foreign ones.

Table 4.1b: Alternative indicators of absorptive capacity
(insert here)

Six alternative indicators used to measure the absorptive capacity of surveyed firms are presented in Table 4.1b. These indicators are respectively the share of engineers in total employment, the share of white-collar personnel in total employment, the share of R&D expenditures in turnover (R&D intensity), the share of export in turnover (export intensity), the number of patents granted and sales per employee.

An important number of high-skilled employees is an important indicator of advanced technological capabilities. Besides, the most important requirement for being able to operate effectively complex production technologies and for performing R&D and innovation activities is an advanced absorptive capacity at the firm-level. Data on the human capital level of foreign and local suppliers show that the proportion of skilled personnel is higher in foreign firms compared to local suppliers, and the difference is statistically significant for both indicators of human capital.

Another argument in favor of a more advanced absorptive capacity for foreign firms is the R&D intensity of foreign firms which is higher than that corresponding to local suppliers although the difference is not statistically significant.

Foreign firms are mainly much more export-oriented than their local counterparts - the difference between export intensities corresponding to each category significant at the 10% level. On average around 45% of the sales of foreign firms are sent to the overseas markets. International markets are more competitive than the domestic market, and they require the capability to deal with stringent demands of consumers and more advanced technological production capabilities pertaining to the products and production processes (aimed at quality control, low defect rate, high quality, tests,

design, etc.). Therefore, our data suggests that more export-oriented foreign suppliers are in possession of these qualities, anyway to a larger extent than local suppliers.

Highly-qualified workforce and R&D activities are indicators of inputs to the innovation process of suppliers whereas patents are the output indicators related to this process. Although the average number of patents granted to local firms is very low (1.6), they are higher than the number corresponding to foreign suppliers (0.83) – but the difference is not statistically significant at 10%. Yet this doesn't mean that the local firms are more successful than the foreign firms at converting their technology expenditures into patents because most of advanced R&D activities leading to patent applications are conducted at headquarters by parent company. Or it may be that foreign suppliers make use of patents granted to their parent company at the home country for their production activities in Turkey.

The average total sale per person of foreign suppliers is almost twice as much larger than local firms (significant at 5% level). In other terms, foreign suppliers are more productive than local ones. Intangible proprietary assets of the parent company transferred to its affiliate in Turkey materializes in the quality of human capital, the amount of R&D activities, i.e. in technological capabilities, and exert a positive effect on the productivity level.

In sum, almost all the indicators in Table 4.1b point in the direction of a higher absorptive capacity in foreign than local firms.

Table 4.1c indicates the distribution of the answers of the firms for the four statements concerning design capabilities. The last category stating “our firm is entirely responsible for all stages of product design” concern those suppliers with the most developed design capabilities (1-High) whereas the category “all technical specifications, design and quality standards of products produced are determined by customers” concern those suppliers possessing the least advanced design capabilities (4-Low). We evaluate the design capabilities of the firms by trying to identify their degrees according to these two end points

When the results are evaluated for all firms, the proportion of firms in the first category is 30% while the proportion for the last category is 52%. Most of the firms (61%) are in an intermediate position in terms of their design capabilities. In other words, , design capabilities of the majority of firms are rather weak. Note that no statistically significant difference exist between foreign local suppliers for design capabilities whereas such higher performance could be expected because of the higher absorptive capacity of these firm figures in Table 4.1b point to.

Table 4.1c: Different levels of design capability
(insert here)

Data in Table 4.2 indicate that 120 over 165 supplier firms (73%) in our sample are owned entirely by national agents while the rest, i.e. 25 firms (27%) are owned by foreigners to different degrees. This table also shows that almost half of these 25 foreign firms are fully owned by foreign agents while 16

of them are partly owned with the share of foreign capital in firm equity being between 40 and 69%. Minority- and majority-owned foreign firms, as defined in Table 4.2 are very limited in number.

Table 4.2: Distribution of suppliers by ownership structure
(insert here)

Data not reported here about the country of origin of foreign supplier firms indicate that most of them are from Germany (29%), USA (13%), France (11%), Japan (9%), Italy (9%) and Spain (7%). These companies are owned by foreign agents to different degrees, except for Japanese firms which are whole owned by Japanese capital.

Size distribution of supplier firms is presented in Table 4.3. Although seven different size classes are given in this table, the usual classification distinguishes between small (10-49 employees), medium (50-249 employees) and large (more than 250 employees) enterprises. Data indicates that our sample comprises mostly medium (53%) and large (38%) while only about 9% are small firms. This confirms our remarks made in the previous section concerning the fact that our sample is about the first- and possibly some second-tier part and component suppliers. A chi-square test points to a significant difference at the 10% level between the size distribution of direct and non-direct suppliers in the Turkish automotive industry in the year 2008.

Table 4.3: Size Distribution of suppliers
(insert here)

Table 4.4 provides data on the year of establishment of automotive supplier firms. Data indicates that 83 of all firms were established from the 1970s on. Although local firms were established in a relatively balanced manner in all the four decades from the 1970s to the 1990s – with 33% of them established in 1970s in response to incentives provided by the import substitution policies of that time – a different picture arises from Table 4.4 for foreign firms. Indeed, although during the 1970s 29% of foreign supplier firms started their operations in Turkey through the creation of joint ventures, 56% of these firms were created later in the 1990s and 2000s. Custom Union agreement signed between the EU and Turkey in 1995 which eliminated trade barriers faced by industrial products and the desire to serve a rapidly growing automotive market are the main causes of this evolution.

Table 4.4: Distribution of suppliers by establishment year

(insert here)

As a result, foreign firms are younger than local ones: indeed, the mean age for foreign firms is 18 years in 2010 whereas it is 29 years for local firms. A chi-square test indicates that there is a statistically significant difference between the ages of these two categories of firms at the 1% level. No such significant difference is observed between direct and non-direct supplier firms.

Table 4.5 provides information on the export intensity of supplier firms[27] for different intensity classes. Only 8.5% of all firms are not exporters while 91.5% do export. Exporters seem to be distributed relatively evenly in the first six classes while only 3.6 of them do export more than 90% of their sales. On average exports accounted for44% of sales of foreign firms and only for 35 for local firms. A chi-square test indicates that the difference between the two groups is significant at the 1% level. Moreover, while the proportion of local exporter firms in the 41-50% class is higher than that of foreign firms, i.e. 12.5% versus 8.9% respectively, the ordering is inversed in the last class with a proportion of 8.9 for foreign firms versus 1.7% for local firms.

Table 4.5: Distribution of suppliers by export intensity (%)
(insert here)

Table 4.6 presents information on the major markets for suppliers in the automotive sector in Turkey[28]. It turns out that 95% of all firms point to the domestic and the EU markets as the major destinations for their sales while Middle Eastern, Asian and USA markets constitute the rest. Domestic markets seem to be more important for local firms while the EU market is more important for foreign firms, although no statistically significant differences are found in both cases. All the same the fact that 35% of local firms consider the European market as their principal market point to the presence of Turkish supplier firms in global value chains. 4.4% foreign firms consider Middle East as their preferred market while the corresponding figure for domestic firms is 1.7% and the difference is statistically significant at the 10% level.

Table 4.6: Distribution of suppliers by market orientation (%)
(insert here)

Our survey included a question relative to the main products manufactured by supplier firms. More precisely, they were asked to name their main product or products with a maximum number of three and their respective shares in their sales. The number of firms that specified only one, two or three products is 26, 17 and 122, respectively. In order to identify the technological complexity of the products(s) manufactured by suppliers, we proceeded in the following manner.

[27] Export intensity is defined as the ratio of export to sales.
[28] Surveyed firms were asked to declare three markets by decreasing importance for their products. In Table 4.6, the most important markets pointed to by surveyed firms are presented.

First, we analyzed the characteristics of the main product(s) manufactured by these firms to establish a technological complexity classification. For those firms which declared having more than one main product, the shares of the second and third products in sales were examined as well as the extent to which these products were technologically related. Our analysis indicates that on the one hand the share of the second and third products in total sales was much lower than that of the first product and that all these products were part, in general, of the same product group, i.e. with a similar degree of technological complexity. Second, engineers affiliated with several automotive manufacturers as well as those affiliated with automotive parts and components manufacturers were consulted to establish the aforementioned technology complexity classification. Factors such as the knowledge and technology content of the products, whether it is a commodity-type product, the complexity of the manufacturing process and its position in the value chain (primary or secondary product or raw material) were all taken into in order to conduct such a classification[29]. Our findings are presented in Table 4.7 below.

Table 4.7: Distribution of suppliers according to technological complexity of their products (insert here)

Data in Table 4.7 indicate that 52% of all firms are manufacturing technologically complex or high-tech products while medium-tech and low tech products constitute 31% and 17% of their sales. 69% of foreign-owned firms are involved in high-tech production while the corresponding share for local firms is 45%. A two-sided Mann-Whitney U test shows that the difference is significant at the 1% significance level. Therefore, it seems that foreign supplier firms are technologically more advanced than local firms, which deal with somewhat technologically lower level production processes and products. The sources of this "technology gap" should be analyzed and policy proposals designed to mitigate it. A similar statistical difference is observed between direct and non-direct supplier firms as well.

4.2 Analysis of the main channels of knowledge and technology transfers from customers to automotive suppliers

In this section, we will examine various types of knowledge and technology transfers (KTTs) accruing from customer companies to their automotive suppliers in Turkey, especially those (i) related to production processes and products (ii) implemented through trainings given/provided to suppliers by their customers and (iii) achieved - albeit in an indirect manner- through financial assistance. A thorough analysis of these various channels of KTT and their relative importance will shed a light on

[29] For instance, parts or components as motor, gear box, suspension, braking system, safety systems, and so on (in primary product class) were classified in the *high-technology category*; the parts as various automotive fasteners, headlight, ventilation ducts, damper, seat, internal trim materials and such in the *medium-technology category*, and the parts as mudguard, seat cover, indicator, signal arms, mirror and exhaust silencer in the *low-technology category*.

the importance and the nature of linkages occurring in the Turkish automotive industry between manufacturers and suppliers.

4.2.1 Knowledge and technology transfers (KTTs) related to the production processes

Thirteen different types of production process-related KTTs occurring in direction of suppliers and originating from their customers are presented below in Table 4.8. Note that initially, respondents were asked to choose amongst five different types of KTT and indicate the frequency of the type of KTT involved[30]. Respondents were also asked to add any other production process-related KTT not mentioned in the survey questionnaire. The five KTT channels proposed initially in the questionnaire are: (i) assistance for design (ii) assistance for R&D activities (iii) providing know-how (iv) assistance for logistic management and (v) providing documentation. We expect the content/quantity of the knowledge transferred, and its strategic importance for the supplier, to decrease from (i) to (iv).

Table 4.8: Types of knowledge and technology transfers related to production process
(insert here)

Note that Table 4.8 does not include information for the "never" category but this information can be obtained readily for each item by summing and subtracting the proportions of answers given to two other categories (*often* and *sometimes*).

When the "often" responses given by all the firms are examined, it is observed that providing documentations (33 %), assistance for logistic management (15 %) and quality control (14 %) are the most frequently selected items by at least 10 % of respondents. They are followed by two channels of KTT involving transfer of know-how (10.4 %) and assistance for R&D activities (10.3 %) from customers to suppliers. The proportion of local firms which receive documentation (36 %) and assistance for logistic management (16 %) is larger than the corresponding share for foreign firms, respectively 24 % and 9 %. Furthermore, the observed difference between local and foreign firms is statistically significant at the 10% level. A contrary situation is observed for KTT accruing to suppliers through know-how transfers.

Data in Table 4.8 point out that, compared to foreign firms, local suppliers tend to be involved in those production-related KTTs which are less knowledge-intensive and of a lesser quality. Only 9 % of local suppliers receive assistance from their customers for their R&D activities and even a lower proportion for their design activities (7 %). Although there are no statistically significant differences between foreign and local for these aforementioned high level KTTs, the absence of these transfers may not have the same implications for both group of firms: indeed, the low figures for foreign firms may be due to the fact that they have advanced design and R&D capabilities and therefore do not need to interact with their customers in order to benefits from KTTs. On the other hand, figures

[30] The alternatives offered were: (i) *often* (ii) *sometimes* and (iii) *never*.

concerning local firms may point to the absence of much needed production-related KTTs, with negative implications for their production and innovation capabilities.

When suppliers that selected the "sometimes" category are analyzed, although the proportion of all firms that indicated this category is significantly higher than those selecting the category "often" for all the items, the remark made above about the low knowledge intensity of KTTs accruing to local firms remains valid: 58 % of local firms receive assistance from their customers on logistics while the corresponding share of foreign firms is 56 % while 62 % of foreign firms benefit from know how flows originating from their customers versus only 50 % for local firms (the difference is statistically significant for both items). The only difference/case that contrasts with the above judgment concerns the transfer of codified knowledge in the form of documentations related to the production process (the first item in table 4.8).

In addition, KTTs aiming at the production processes and which occur the least are can be identified by the proportion of suppliers that choose the "never" category : granting of patent/license rights to suppliers (73 %), assistance for business management (68 %), involvement of customer's staff in launching the operations of the plant (64 %). The figures for the five items initially included in the questionnaire are: (i) providing documentations (11 %) (ii) assistance for logistic management (37 %) (iii) providing know-how (31 %) (iv) assistance for R&D activities (36 %) and (v) assistance for design (35 %). A tendency seems to exist for this proportion to increase with the quality and strategic importance of knowledge provided to supplier firms by their customers.

4.2.2 Knowledge and technology transfers related to products

Table 4.9 below shows the proportion of suppliers involved in product-related KTTs to different degrees (i.e. often and sometimes).

Table 4.9: Types of knowledge and technology transfers related to products (insert here)

49 % of respondents declared that they benefited from KTTs in the form of technical specifications, original design or technical drawings (SDDs) from their customers while this figure falls to 26 % for both transfers related to joint operations and product specifications. Two last items included in Table 4.9 are those that require an important level of absorptive capacity on the part of suppliers but also present the most important potential for product-related KTTs. They are the KTT-related activities that occur least frequently, hence pointing to their difficulty or strategic issues involved. Besides, the first product-related KTT activity, which probably provides basic codified information to suppliers and does not require an advanced absorptive capacity on their part to make use of the knowledge transferred, concerns 56 % of local *versus* 31 % of foreign firms – and the difference is statistically significant at 1 % level. In other words, as far the "often" category is concerned, local firms tend to benefit mostly from the low-tech kind of product-related KTTs. On the other hand,

while there is no statistical difference at the 10 % level for the last two knowledge-intensive KTT items between foreign and local firms, such a significant difference exists between direct and non-direct suppliers firms at the 1 % level. Hence, being a direct supplier of automotive manufacturers operating in Turkey and therefore being more close to customers in the supply chain value exerts a positive effect on the type of KTT.

When respondents which opted for the "sometimes" category are analyzed, a different picture arises. Indeed, the last two product-related KTT channels are now among the most frequently used ones with more than 50 % of suppliers involved in each of them. This last finding is probably due to the fact that customers aim to guarantee/ensure critical characteristics of inputs such defect rates, quality and delivery on time so as to not encounter any major problems later on the production lines. As such, these KTTs about product design are a prime example of conscious/deliberate technology transfer from customers to their suppliers through backward linkages. On the contrary, the previously most frequent KTT item (SDDs) is now experienced only by 34 % of suppliers, which is the lowest proportion for the "sometimes" category. Moreover, 40 % of foreign suppliers declare they are involved in this kind of product-related KTT activity while the corresponding figure for local firms is only 32, and the difference is statistically significant at the 1 % level. Figures concerning direct suppliers for the last two KTT items confirm the advantages of the proximity to automotive manufacturers pertaining to the nature of the transfers realized – and the difference between direct and non-direct suppliers is statistically significant.

4.2.3 Knowledge and technology transfers occurring through training

Many of the previously examined KTT activities, whether related to production processes or products, entail the transfer of codified knowledge form customers to their suppliers. However, as is well known, some strategic knowledge exists only in tacit form and is embodied mainly in individuals and organizations. Therefore, its transfer requires face-to-face contacts between employees of manufacturers and supplier firms in the automotive sector. One major way to achieve transfer of tacit knowledge from manufacturers to suppliers is by organizing trainings sessions that targets employees of supplier firms. These training sessions can be of different types and be provided under different forms/modalities. Responses of suppliers to the questions on KTTs occurring through training are presented below in Table 4.10 for different types and modalities of trainings.

Table 4.10: Knowledge and technology transfers through training: forms of training
(insert here)

Information on three different types of trainings is presented in Table 4.10, i.e. trainings on production technologies, trainings targeting production and management staff of suppliers. Data is provided for both the "often" and the "sometimes" categories. One first notices that the proportion of all firms that declared being subject to at least one of these three types of trainings, 11 %, is much

lower than the corresponding shares of product- or process-related KTTs (see Table 4.8 and Table 4.9). In other words, transfer of tacit knowledge occurs relatively less frequently than transfer of mainly codified knowledge. This might be due to the more difficult and costly nature transferring knowledge embodied in people and organizations since face-to-face contacts between employees of manufacturers and suppliers are required for an effective KTT through training to occur. In addition, the more strategic nature of tacit knowledge may dissuade some automotive manufacturers from transferring it to their suppliers in order to maintain/conserve their bargaining power in supply value chain, especially if trust between the two parties is not strong enough.

Whatever the causes/factors behind these low proportions, data indicate that 11 % of suppliers receive training on production technologies while training provided to production workers and managers concern 10 % and 7 % of suppliers, respectively. The proportion of foreign firms subject to all three kinds of training is higher than for local firms, pointing to the advantages of foreign ownership in the transfer of tacit knowledge - the difference, however, is not statistically significant at 10 %, however. On the other hand, a significant difference exists between the proportion of direct and non-direct supplier firms benefiting from these three types of tacit KTTs. When responses with the "sometimes" option are examined, the difference between the foreign and local firms observed earlier is reduced – for instance, 54 % of local firms declare their engineers and technicians receive training from their customers while the corresponding proportion is 47 % for foreign firms. In any case, 52 % of all firms did never benefit from KTT occurring through the first type of training, 38 % from the second type of training and 43 % from the third type of training. These proportions are higher than those related to production and especially product-related KTTs discussed earlier, pointing once again to the less frequent character of this type of knowledge.

Trainings provided by customers can be classified according to the modalities used, as well. In Table 4.11 we distinguish between three main modes of training. The first one consists in visits of supplier's staff to customers' plants, which is mainly a kind of visual inspection with low potential of tacit knowledge transfer[31]. Next we have two more channels of trainings: (i) on-the-job training focusing on theoretical and/or applied issues and (ii) off-the-job training organized through seminars and courses.

Table 4.11: Knowledge and technology transfers through training: modes of training (insert here)

Off-the-job training activities are classified in three groups according to their location: (i) supplier's own plant (ii) specialized institutes and (iii) customer's plant. 46 % of all respondents declared that they received trainings in their own plant on a frequent basis while 22 % and 7 % pointed to specialized institutes and customers' plants, respectively as locations of this type of frequent training. 27 % of foreign firms benefit from trainings taking place in specialized institutes while the corresponding figure for local firms is 20 %, with the difference being statistically significant at the 1% level. When responses given to the *sometimes* category are analyzed, it is observed that

[31] This channel of tacit KTT may simply reflect the existence of close relationships between the supplier and the customer. By itself, it is probably of low significance as a channel of tacit knowledge transfer.

respondents declaring benefiting from trainings in specialized institutes and customers' plants increase significantly to 67 % and 66 % respectively. Compared to local firms, foreign firms are more intensively involved in these two types of tacit knowledge transfers. The statistically significant difference for trainings received at customers' plants may point to more close relationship between foreign firms and their customers as well as to their higher level of absorptive capacity – required for the knowledge transfer through trainings to be effective. At the end, only 8 %, 11 % and 32 % of all firms declare they were never involved in these three respective tacit KTT channels.

As for the *on-the-job training channel*, it turns out that the frequency of this type of KTT channel is even lower than that of off-the-job training activities: 5 % of all firms declare being concerned with this type of KTT at customers' plants –in Turkey or abroad – on a frequent basis while 7 % are involved in this activity in their own plant. It can be pointed out that 1.7 % of local firms attend frequently this type of training *abroad* at their customer's plant while none of the foreign supplier firms do - and the difference is significant at the 5 % level. When figures about on-the-job trainings occurring on an occasional basis (*sometimes*) are examined, the frequency of this mode of training rises enormously: 65 % of all firms declare being involved in this type of KTT, with the frequency observed for foreign firms (84 %) is much larger than the one for local firms (57 %). Furthermore, 40 % of foreign firms do attend trainings organized at their customer's plant abroad while the corresponding figure for local firms is only 22 %, and the difference is statistically significant at the 5 % level. In a similar vein, the share of all suppliers involved in organizing in-house on-the-job training activities is 41 %. At the end, only 30 % and 52 % of all firms declare they were never involved in these two KTT activities occurring via on-the-job training.

Finally, as far as the last modality of KTT through training – i.e. *visits by suppliers to their customers' plants* – is concerned, 29 % of all firms declare attending these visits on a frequent basis while 64 % do it on an occasional basis. In other, only 9 % of firms have never visited their customers' plants. Note that these visits take place in accordance to a predetermined program and suppliers' staff visits their customer's plants in order to receive a kind of visual and verbal education/training about customers' products and production processes by entering directly in contact with specialized personnel. According to data presented in Table 4.10, 21 % of local firms attended these visits on a frequent basis *versus* 13 % of foreign firms while the corresponding figures for the 'sometimes' category are 61 % and 71 %.

In summary, data in Table 4.10 shows that customer firms – mainly automotive manufacturers – do transfer tacit knowledge to their suppliers through different types of training targeting especially production personnel. The main motivations of customers in organizing these trainings[32] is to enhance their suppliers' production, design and R&D capabilities so as to be delivered on time with better quality, low cost parts and components so that the manufacturing process goes on smoothly. It is remarkable that KTT activities involving transfer of tacit knowledge from customers to suppliers in the automotive industry concern such a high proportion of suppliers – foreign or local – and are carried out via such diverse modalities. According to us, this points to/confirms the vitality of KTT activities occurring within the automotive industry in Turkey, especially when the transfer of tacit knowledge embodied in agents – hence more difficult to transfer – is concerned.

[32] Note that these activities are costly in terms of direct expenses as well as opportunity costs incurred by customers, especially when on-the-job training is concerned.

4.2.4 Financial transfers/assistance carried out by customers

Information on financial assistance provided by customers to their suppliers is presented in Table 4.12. Except the first type of financial transfer bearing on pre-finance of machinery, equipment and tools acquisition, the remaining instruments/modalities do not directly contribute to KTT to supplier firms but may exert a positive – and sometimes critical – effect on their survival rates by ensuring flow of financial resources when needed. By increasing their survival chances, these types of assistances may play a crucial role in the activities of suppliers.

Table 4.12: Financial transfers by customers (%)
(insert here)

Data in Table 4.1 shows clearly that transfers involving financial resources occur much less frequently compared to KTT-related transfers. Only 11 % of all firms declare benefiting on a frequent basis from financial aids granted by their customers in order to acquire technologies embodied in hardware. These aids concern 9 % of local firms and 18 % of foreign firms with the difference between these two groups being statistically significant at the 10% level. As for the prepayments made before delivery of orders, 7 % of all firms do benefit from this practice frequently. This proportion falls to 1.2 % and 0.6 % for loans with low interests rates and contribution to risk capital by customers, respectively. None of the suppliers are involved frequently in unilateral financial aid provided by their customers.

When responses in the 'sometimes' category are analyzed, the proportion of firms involved in pre-financing of codified knowledge embodied in hardware increases substantially and attains 40 %. The difference between foreign and local firms remains statistically significant. Prepayments for orders concern now 35 % of all firms while the corresponding figures for the remaining three financial aid channels/modalities are never over 7 %. In other words, 93 % of firms have never benefited from unilateral financial aid nor from low-interest loans provided by their customers, 96 % of firms did not experience any contribution of customers to risk capital, 57 % have never experienced any prepayments made before deliver of orders. Therefore, we can conclude that customers, mainly automotive manufacturers, in the Turkish automotive industry do not prefer assist their suppliers through financial assistance. However, for those customers who are involved in such transfers the preferred means turn out to be pre-financing of machinery and prepayments made before deliver of orders.

4.2.5 Motivations for collaboration of automotive suppliers with other firms

One precondition for the existence/occurrence of KTTs towards automotive suppliers is that they decided to collaborate with other firms to this end. One question is included in the survey questionnaire in order to determine the motivations of suppliers for establishing inter-firm

collaborations and the importance attached to each of them. The five factors included in the survey initially are: (i) conducting R&D activities (ii) transferring know-how (iii) establishing long-term strategic partnerships (iv) improving product quality and (v) being informed about the new technologies. An option was left for respondent firms to mention other factors not included in the list. They were asked to determine the importance attached to each motivation on five-point Likert scale (1=very unimportant and 5=very important). Data on factors conducive to collaboration and estimated to be important or very important – values 4 or 5 on the Likert scale – by supplier firms are presented in Table 4.13 below.

Table 4.13: Why do automotive suppliers collaborate with other firms? (%)
(insert here)

More than 70 % of suppliers attribute a high degree of importance to the first three items in Table 4.13 for establishing collaborations with other firms while 69 % consider opening up to global markets a valuable reason for collaborating with other firms. 80 % of suppliers, foreign or local, consider product quality improvement as a critical factor for collaborating with other firms. This points to the existence of advanced design capabilities in supplier firms since such competencies are required to conduct product quality-improving activities. Compared to foreign firms, a higher proportion of local firms emphasize the critical role of the following factors in establishing inter-firm relationships: *learning about new technologies* (75 % *vs.*60 %), *opening up to global markets* (73 % *vs.* 64 %) and *entering new technology fields* (74 % *vs.* 53 %). In all three cases, differences between local and foreign suppliers are statistically significant. In contrast to the first motivation (*improving product quality*), these last three ones do not aim – at least directly – at acquiring KTTs to be used in the production or innovation process but relate rather to deal with new markets abroad or with new technologies.

Findings related to new technologies may indicate that suppliers collaborate with their customers to learn about the existence and/or the workings of technologies new on the world or domestic markets – in which case customers play the role of technology gatekeeper for suppliers as well as locus of learning-by-doing activities involving new technologies. The statistically significant difference between local and foreign firms also confirms that absorptive capacities[33] of local firms are weaker than those of foreign firms and hence they need to cooperate with other firms – especially their customers – to compensate for this lesser absorptive capacity. Besides obtaining information on the existence, size and peculiar characteristics of new markets abroad, collaboration aimed at *opening up to new markets* and *sharing production costs or risks* may well reduce risks associated with operating in new markets abroad (unchartered territories) and provide suppliers with the benefits of scale economies.

57 % of firms cooperate with other firms - most probably, their customers - in order to carry out R&D activities, with this proportion being larger for local (61 %) than for foreign firms (47 %). Cooperating with other firms is a natural/major way to benefit from their competencies in the R&D process and share technical and commercial risks as well as development costs. Another reason for

[33]Defined as firms competencies required to identify, acquire, use, adapt, assimilate and modify embodied and disembodied technologies related to products and production processes. See Cohen and Levinthal (1991).

collaborating with the customers is the prospect of finding a ready market (customer/demand) for the product developed when and if the R&D project ends. Establishing long-term strategic partnership -pointed to by 55 % firms- may be explained by similar factors.

One quasi-mystery remains the finding that the least important motivation for cooperation pointed to by firms is know-how transfer: only 49 % of suppliers find it important or very important for collaborating with other firms. Indeed, one may expect that the occurrence of such knowledge flows/transfers constitute an important reason for collaboration between suppliers and automotive manufacturers. This relatively low figure for this item may be due to two factors: (i) respondents pointing to collaborations launched for know-how transfer and aimed at improving product quality may be included in the first item indicated in Table 4.13 (*improving product quality*) and hence excluded from the responses to the last item or (ii) if the know-how transfer mentioned in the last item relates to the production process or is perceived as such by respondents, the low response rate for this item may simply reflect that the fact that production capabilities of (local) automotive suppliers in Turkey is relatively more developed than their design and innovation capabilities.

4.3 Econometric analysis of the determinants of knowledge and technology transfers from customers to suppliers in the Turkish automotive industry

In this section, an econometric analysis will be conducted in an attempt to identify factors impacting on different types of KTTs discussed in the previous section. First, the econometric estimation method used will be examined below with an emphasis on the interpretation of the coefficients estimated. Second, explanatory variables introduced in the regressions will be examined and finally, findings will be presented and analyzed.

4.3.1 Ordinal logistic regression model and explanatory variables

Since all KTT-related indicators constructed from the survey questionnaire are categorical but ordered variables -categorical variables with a sense of ordering- *ordinal logistic regression model* will be used to examine determinants of KTTs accruing to automotive suppliers in Turkey. Surprisingly, there seems to be very few studies investigating factors that influence KTTs accruing from customers to their suppliers in the automotive industry of emerging economies[34]. The quantitative study conducted in this paper aims at filling the gap in this domain.

Two points about the ordinal logistic regression model is worth mentioning[35]. First, the estimated coefficient of an explanatory variable in this model does not necessarily inform us about its marginal effect –i.e. change occurring in the probability of observing a category associated with a unit change

[34] Berger (2005), Giroud (2003), Techakanont (2002), Techakanont and Terdudomtham (2004), and Wasti (2006).
[35] On the ordinal logistic models, see Maddala (1983), Liao (1994), Long (2001) and Verbeek (2008).

in the explanatory variable– but rather about the change in the log of odds of being in a higher level of the dependent variable, given that all the other variables in the model are held constant. The sign of a coefficient associated with a variable is not necessarily the same as the sign of its marginal affect. For instance, Verbeek (2008) points out that for an ordinal dependent variable comprised of three categories with increasing intensity, a positive coefficient associated with an explanatory variable indicates that if this variable increases, the probability that the most intense category occurs will increase while the probability of the least intense category will decrease. The impact on the probability of the occurrence of the intermediate category is ambiguous since its probability might increase or decrease[36]. Second, when using this regression model, the parallel regression assumption is maintained, meaning that the relationship between each pair of categories included in an explanatory variable does not change. This last point will be illustrated below while examining the results of our econometric analysis.

Based on the collected survey data, a number of indicators have been constructed to be used as explanatory variables in the regressions. There are eight potential determinants of KTT-related activities we have been able to construct from survey data.

The first variable is simply the *age of a supplier* and has been constructed by subtracting the establishment year of the supplier from 2010, which is the year when the survey was conducted. Age of a supplier may indicate its experience in the automotive sector and proxy the extent to which it might have trust-based relationships with its customers. The higher the trust between both partners, the lesser the transactions costs incurred and the higher will be the probability to experience KTT-related activities with customers. On the other hand, more recently established suppliers may act more aggressively in contradiction to the older suppliers, which may show signs of rigidity and cannot adapt to a changing environment (lock-in phenomenon) (**Age**).

The second explanatory variable is *firm size* measured as the logarithm of the number of employees. Firm size may proxy a host of variables potentially affecting KTTs: (i) scale and scope economies in the production process (ii) cost and availability of financial resources and (iii) extent of the labor division within the firm. It may affect negatively KTT-related activities of suppliers since large suppliers may be self-sufficient and demand les KTT from customers. However, increasingly, even the human and financial resources of the largest firms cannot be sufficient for conducting R&D and innovation activities, leading them to collaborate with other firms. In addition, it is also admitted that firm size may act as a proxy for production capabilities since it is related to the production capacity or scale of firm. Empirical studies show that automotive manufacturers tend to consider strong production capability as a necessary condition for the establishment of KTT-related activities with suppliers (**Size**).

[36] The probability of occurrence of the intermediate category may increase for some values of an explanatory variable and decrease for others: see Long (2001).

The third variable introduced in the regressions is the *export intensity* of supplier firms, measured as the ratio of exports to their sales. Following the economic crisis of the year 2001, automotive manufacturers as well as suppliers in Turkey increased the proportion of their sales sold on world markets. The intense competition prevailing on abroad may oblige supplier firms to cooperate with their customers in order to improve the quality of their products, receive know-how pertaining to the production process in order to increase its efficiency and to carry out design-related activities. In some instances, these KTT-related activities may be conducted with the help of customers abroad. Therefore, the impact of this variable depends also on the position of supplier firms in the supply chain of multinational companies (**ExpInt**).

The fourth explanatory variable is a binary one and takes the value of 1 if a firm declares being the *direct supplier* of at least one automotive manufacturer established in Turkey, 0 otherwise. By direct supplier, we mean the first tier suppliers working directly with the main automotive manufacturers. This close relationship may be associated by the production of the relatively sophisticated of part and components for customers and hence more prone to KTTs. By definition, the likelihood of second- and third-tier suppliers to benefit from such an advantage is extremely low. Having a good reputation in the sector, benefiting from a stable demand and being part of design activities in its early stages are other –potential- advantages of being a direct supplier which may exert a positive influence on KTT-related activities[37] (**DSF**).

The fifth explanatory variable informs us whether a supplier firm is owned by foreign agents. It is a dummy variable that take the value of 1 if the share of firm equity owned by foreigners equals at least to 10 %, 0 otherwise. *Foreign suppliers* may possess a number of intangible proprietary assets that enable them to compete with domestic suppliers without any need of KTTs. On the other hand, these same proprietary assets mat enable them to pursue advanced design-related KTTs with their customers, which may operate in Turkey or abroad, especially if they are asked by their customers to manufacture technologically sophisticated parts and components. If it is an affiliate of a foreign MNC, it might transfer knowledge and technology from its parent firm. Hence, the effect of this variable on KTTs remains an empirical issue (**Foreign**).

The sixth variable is a binary one as well and it informs us whether a supplier firm is part of a larger group, a parent company or conglomerate. Such a membership may be conducive to KTTs in case (i) the supplier firm work for a manufacturer itself part of the larger group, since this can reduce transaction costs and build trust between both firms. On the other hand, such a status may exert a negative effect on KTTs since the role attributed to the supplier within its group may not be conducive to such relationships. This negative effect may also be the result of the formal technology transfer channels used by the group –i.e. technology licenses- which reduce the need of KTTs (**GroupLoc**).

The seventh variable is also a binary variable indicating whether a supplier firm has a multinational company (MNC) among its customers. If this is the case, then MNCs can impact positively on KTTs of suppliers by being more stringent on issue such as delivery time, quality, costs and also by selecting among its suppliers those capable ones to act as co-designer for it. Of course, the position of suppliers in the supply chain of MNCs is also important for the final outcome. This assumption has been tested by introducing this binary variable in the regressions (**ClientMNC**).

[37] Pamukçu and Sönmez (2011).

Finally, the last explanatory variable introduced in the regression is a binary variable indicating whether a supplier conducts or not R&D activity. This variable is an indicator of the level of the absorptive capacity of suppliers. A higher absorptive capacity may signal to automotive manufacturers the higher potential of a supplier in such innovative activities as co-design, product quality improvement, product development, etc. and therefore foster cooperation between the two parties (**R&D activity**).

Summary statistics on the explanatory variables are presented in Tables 4.1a and 4.1b. A correlation matrix containing simple correlation coefficients between explanatory variables is given in Table 4.14. In the remaining part of this section, findings of the econometric estimation for various KTTs accruing to suppliers will be presented and examined.

Table 4.14: correlation matrix for explanatory variables
(insert here)

4.3.2 Knowledge and technology transfers related to the production processes

Estimation results for production-related KTTs are presented below in Table 4.15. Note that these transfers may take the form of assistance for design, R&D activities or logistics management or occur through providing know-how and various documentations. Three degrees of importance are associated with each type of KTT: (i) *never* (ii) *sometimes* and (iii) *often*.

Table 4.15: Determinants of knowledge and technology transfers related to production process
(insert here)

A significant and negative association exists between *firm age* and the frequency of KTTs occurring through know-how on production-related issues. A one year increase in the age of a supplier reduces by 0.03 points the log of odds of being in a higher level of the know-how transfer variable, i.e. in the 'often' category compared to the combined 'sometimes and never' category or in the combined 'often and sometimes' categories compared to the 'never' category[38]. Alternatively, by taking the exponential of the estimated coefficient in Table 4.15, one can calculate the impact of the firm age on the *odds* of being in a higher level of the know-how transfer variable, i.e. more frequent

[38] As mentioned earlier, the value of the estimated coefficient implies that being a more experienced firm reduces the probability of more frequent know-how transfers (*often*) while it increases the probability of non-use (*never*) of this type of KTT.

use of this type of KTT. The calculated coefficient for firm age equals 0.97, indicating that a one year increase in firm age increases by 0.97 times the odds of often (combined *often and sometimes*) category with respect to the combined *sometimes and never* (never) category.

In other words, the importance attributed by suppliers to KTTs in the form of know-how related to production processes decreases with the level of experience of the suppliers. This may simply indicate that many experienced suppliers in the Turkish automotive industry do possess a high level of production capabilities which makes unnecessary the frequent know-how transfers from their customers.

The coefficient associated with *being a direct supplier* is positive and significant at the 5 % level. The odds of using *often* (often and sometimes) KTTs in form of production-related design assistance versus the combined *sometimes and never* category (never) is 2.73 ($=e^{1.01}$) times greater for direct than non-direct suppliers. A similar effect is observed for assistance about logistics management. Although there is no obvious explanation as to why being a direct supplier is associated with more frequent use of these two types of production-related, it nevertheless shows that working closely with customers bears some advantages when it comes to more intense use of some KTTs.

As for the coefficients associated with the *foreign ownership* variable, they are negative and statistically significant for assistance given to logistic management and for receiving documentations from customers. The odds of *less* versus *more* frequent logistic assistance is 2.19 ($=e^{0.78}$) times higher for foreign than local firms. Similarly, odds of *less* versus *more* frequent reception of documentations is 2.30 ($=e^{0.83}$) times higher for foreign than local firms. An explanation for the negative association between foreign ownership and the frequency of two types of KTT is that these are the two least knowledge intensive KTT activities and hence are not needed by foreign firms who possess a significant level of technological capabilities.

Finally, being part of a *local group or conglomerate* increases by 2.06 times the odds of *less* versus *more* frequent assistance on logistic by customers with respect to these suppliers that do not have such an affiliation. The explanation of such a finding is not obvious.

4.3.3 Knowledge and technology transfers related to products

Estimation results for production-related KTTs are presented below in Table 4.15. Note that these transfers may take the form of assistance for design, R&D activities or logistics management or occur through providing know-how and various documentations. Three degrees of importance are associated with each type of KTT: (i) *never* (ii) *sometimes* and (iii) *often*.

Table 4.16: Determinants of knowledge and technology transfers related to products
(insert here)

A positive and significant association exists between *firm size* and the frequency of product-related KTTs occurring through joint design activities involving suppliers and their customers. A one percent increase in firm size increases the odds of being involved *often* (often and sometimes) in product-related joint design activities *versus* the combined *sometimes and never* category (never) by (1.53 = $e^{0.43}$) times. As discussed previously, firm size may proxy production capabilities of supplier firms and such capabilities may be necessary for automotive manufacturers to be willing to enter in joint design activities with suppliers.

An increase in *export intensity* increases the probability of frequent occurrence (*often*) of joint design activities while it decreases the probability of non-occurrence (*never*). A similar result is obtained for the occurrence of assistance in the form of technical specifications, original design or technical drawings (SSDs). Both findings are likely to be caused by the peculiar requirements of foreign markets as to the characteristics, nature, quality or performance of products which tend to be different from the ones sold on the domestic market.

Being a *direct supplier* firm increases the likelihood of occurrence of KKTs in the form of assistance provided by customers for product design and joint design activities by both parties. These two product-related KTTs are recognized as being the most sophisticated ones among the five KTT categories included in the survey questionnaire. Hence, being a direct supplier is indeed associated with a number of advantages related to the intense transfer of advanced KTT aimed at products.

The only statistically significant impact of *foreign ownership* is on the SDD form of KTT. It is negative and decreases the probability of frequent use of this type of product-related KTT for foreign firms compared to local firms. Since SDDs are considered to be a relatively simple type of KTT, this finding may suggest that higher technological capabilities of foreign firms reduce the need of this type of KTT. Note that a similar result was obtained while analyzing the impact of foreign ownership on production-related KTTs since being a foreign variable reduces the probability of frequent use of the least sophisticated type of transfer, i.e. provision of various documentations by customers.

Being *part of a local group* exerts a negative impact on the probability of frequent occurrence of assistance aimed at product design, which may suggest that this group of suppliers either possesses already sufficient knowledge on product design-related issues or obtain this knowledge through other means – for instance thanks to its privileged relationships with its parent company.

Finally, those suppliers which carry out *R&D activities* are more likely to conduct more frequent design activities in collaboration with their customers. This also suggests that automotive manufacturers prefer engaging in such advanced activities with those suppliers who have a developed absorptive capacity.

4.3.4 Knowledge and technology transfers through trainings provided by customers

Estimation results on the determinants of various types of training are presented in Table 4.17. Only *firm size* exerts a positive and significant effect on the probability of frequent use of trainings on production technologies while it also influences positively training activities given to the production staff of suppliers. This suggests that customers choose amongst their suppliers those firms with developed production capabilities in order to provide the aforementioned training activities. Being a direct supplier is another variable that impacts positively on the second type of training and this suggest that close relationships of these firms their customers increase the probability of frequent trainings given to their production personnel. Finally, more export intensive firms seems to feel less the need of frequent training targeting their managers, which is difficult to interpret.

Table 4.17 – Determinants of the types of training provided by customers
(insert here)

4.3.5 Financial assistance

Firm size exerts a statistically significant and positive impact on the frequency of provision of low-interest loans by customers to their suppliers. This may be due to the fact that being a larger supplier with significant production capabilities may reduce risks associated with the reimbursement of the loan granted. Being part of a *local group*, however, increases the probability of low frequency associated with the occurrence of such financial assistance to suppliers by their customers. Being a *direct supplier* is the only variable that has a significant and positive effect on the probability of occurrence of financial assistance via pre-financing, which is likely to reflect the advantages of being close partners of automotive manufacturers. Two variables impact significantly and positively on frequency of prepayment before delivery: (i) firm age, suggesting that firms that have been able to establish trust-based relationship with their customers benefit from this type of financial assistance and (ii) firm size which again point to the advantages of possessing advanced production capabilities. On the other hand, having MNCs among its customers impacts negatively the probability of occurrence of this financial aid method by suppliers.

4.3.6 Why do suppliers cooperate with other firms?

Estimation results pertaining to the determinant of motives of suppliers for establishing inter-firm collaborations are presented in Table 4.18 below.

Table 4.18 – Determinants of the motives for inter-firm cooperation of suppliers (insert here)

As far as the *firm age* - proxy for the extent of firm experience and maturity - is concerned, it exerts a negative impact on the degree of importance attached by suppliers to the following motives for inter-firm collaboration: (i) establishment of long-term strategic partnership (ii) improvement of product quality and (iii) learning about new technologies. These three motives for inter-firm collaboration are also recognized as signs or indicators of vitality and dynamism for a firm. Therefore, our findings indicate that these signs of dynamism tend to play a lesser role for older suppliers in as motives for entering in inter-firm collaboration, given that all the other variables in the model are held constant.

Firm size exerts a significant and positive impact on the degree of importance attached to the establishment of strategic partnership and improvement of product quality as motives for establishing inter-firm relationships. This might suggest that once suppliers reach some kind of threshold in their production capabilities, they move on to cooperate with their customers in order to improve quality or their products – an important requirement for becoming and remaining the supplier of automotive manufacturers – and for establishing relationship on a long-term basis. The positive but insignificant impact of firm size on know-how transfer as a motive for inter-firm collaboration points to the advanced production capabilities of suppliers.

Both export intensity and being a direct supplier have a significant and negative influence on the degree of importance attached to the establishment of strategic partnerships for collaboration, given that all the other variables in the model are held constant. These findings are no obvious to interpret.

Foreign ownership impacts negatively and significantly on the degree of importance attached to three motives of inter-firm collaboration: (i) know-how transfer (ii) product quality improvement and (iii) learning about new technologies. Rather than considering these results as a sign of lack of technological dynamism on the part of foreign firms – as was the case for older firms – we believe that they point to the fact that foreign suppliers possess a number of intangible proprietary assets which renders such motives for collaboration less pertinent.

Finally, conducting R&D activity affects positively and significantly the degree of importance attached to all collaboration motives except know-how transfer. Although the positive effect of this variable on R&D motive for collaboration is easily understandable, its positive effect on strategic partnership and quality improvement show the importance of innovation capabilities beyond

production capabilities for inter-firm collaborations to occur while the positive effect on learning about new technologies motive point to the role played by the absorptive capacity in this process.

The main objective of this paper is to evaluate whether interactions with foreign automotive manufacturers in the Turkish automotive industry enable suppliers to upgrade their technological capabilities. One important issue addressed is the extent to which these interactions lead to knowledge and technology transfers from customers to their suppliers through backward linkages.

5. Conclusion

The main objective of this paper is to evaluate whether interactions with foreign automotive manufacturers in the Turkish automotive industry enable suppliers to upgrade their technological capabilities. One important issue addressed is the extent to which these interactions lead to knowledge and technology transfers from customers to their suppliers through backward linkages**.** To this end, a questionnaire was designed and used to collect detailed data and information from auto suppliers present in Turkey. The survey was conducted with the CEOs, R&D, production and product directors of 165 supplier firms in order to investigate the existence, nature and extent of technology transfers from buyers to suppliers. Our main findings can be summarized as follows.

KTTs accrue from customers (MNCs) to their local suppliers mainly 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 KTTs 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 KTTs. Moreover, various types of training have been provided to suppliers by customers. These trainings aim mostly at production staff and occur via off-the job training activities. However, it seems that foreign suppliers are more involved in training activities than local firms. This finding probably indicates that customers prefer to work mostly with foreign suppliers because of their advanced technological capabilities and absorptive capacity level. These types of KTT activities provided by customers aimed generally at new product development process. Therefore, this confirms that strategic relationships between foreign firms and customers are very strong and it reflects that it is necessary to have very qualified personnel to be benefited from these activities. Besides, it seems that customers do not generally prefer providing financial assistance to supplier firms; but if they do so, these assistances in general take mainly the form of pre-financing of machinery and prepayments for orders before delivery

Table 5.1 below is a recapitulative table for econometric findings obtained in this study. It contains signs of coefficients statistically significant at least at the 10% level and that are associated with explanatory variables that impact on different types of KTTs –production process, product, training, financial transfers and cooperation activities.

Table 5.1: Recapitulative table for econometric findings
(insert here)

The only variable that affects positively the *KTTs aimed at the production process* is *being the direct supplier* of an automotive main manufacturer. The other variables age, foreign capital and to be part of a group negatively affect these transfers or reduce the possibility of such transfers.

A larger number of variables influence positively *product–related KTTs* than the transfers related to production process. Firm size, export, being direct supplier and R&D activities increase the possibility of such transfers, on the contrary *foreign capital* and *being part of a group exert a* negative effect on such transfers

Training activities provided by customers to supplier firms may be an important channel for KTTs. Our findings show that trainings are provided mainly to *production personnel* (engineers, technicians) rather than to *managers*. Firm size and being a direct supplier impacts positively on transfers provided to production personnel whereas export intensity influences negatively the transfers provided to management personnel of supplier firms.

The main finding related to factors affecting the establishment of collaboration activities with other firms is that independent variables other than *firm size* and *R&D activities* reduces the probability of frequent occurrence of these activities. An increase in firm size gives rise to an increase in the possibility of establishing long-term strategic partnership (LTSP) and improving product quality. In addition, engage in R&D activities – that is an important indicator of competence – also increase the possibility of collaboration in terms of R&D, long-term strategic partnership, improving product quality and learning about new technologies.

If we look at the findings in Table 5.1 in terms of independent variables used in the regression models, we can make the following observations; *Being a direct supplier* of automotive manufacturers is the most important feature that affects the frequency of terms of transfers for production process, product, training and financial aids. *Foreign ownership* has a negative impact on transfers for product and production process and cooperation activities, a finding probably related to the already developed R&D capabilities of foreign suppliers. *To be part of a local group* has a negative effect on production process, product and financial transfers. Finally, engaging in *R&D activities* affects positively joint-design activities (products), which points to the importance of R&D capabilities for those suppliers which desire to become a co-designer.

The survey conducted amongst suppliers in the Turkish automotive industry and the econometric analysis conducted here using data collected via the survey is the first study of its kind for the Turkish industry. Similar studies using a different target group or different research methodologies should be undertaken to address the issues Turkish automotive industries will have to tackle in the next decades.

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TABLES and FIGURES

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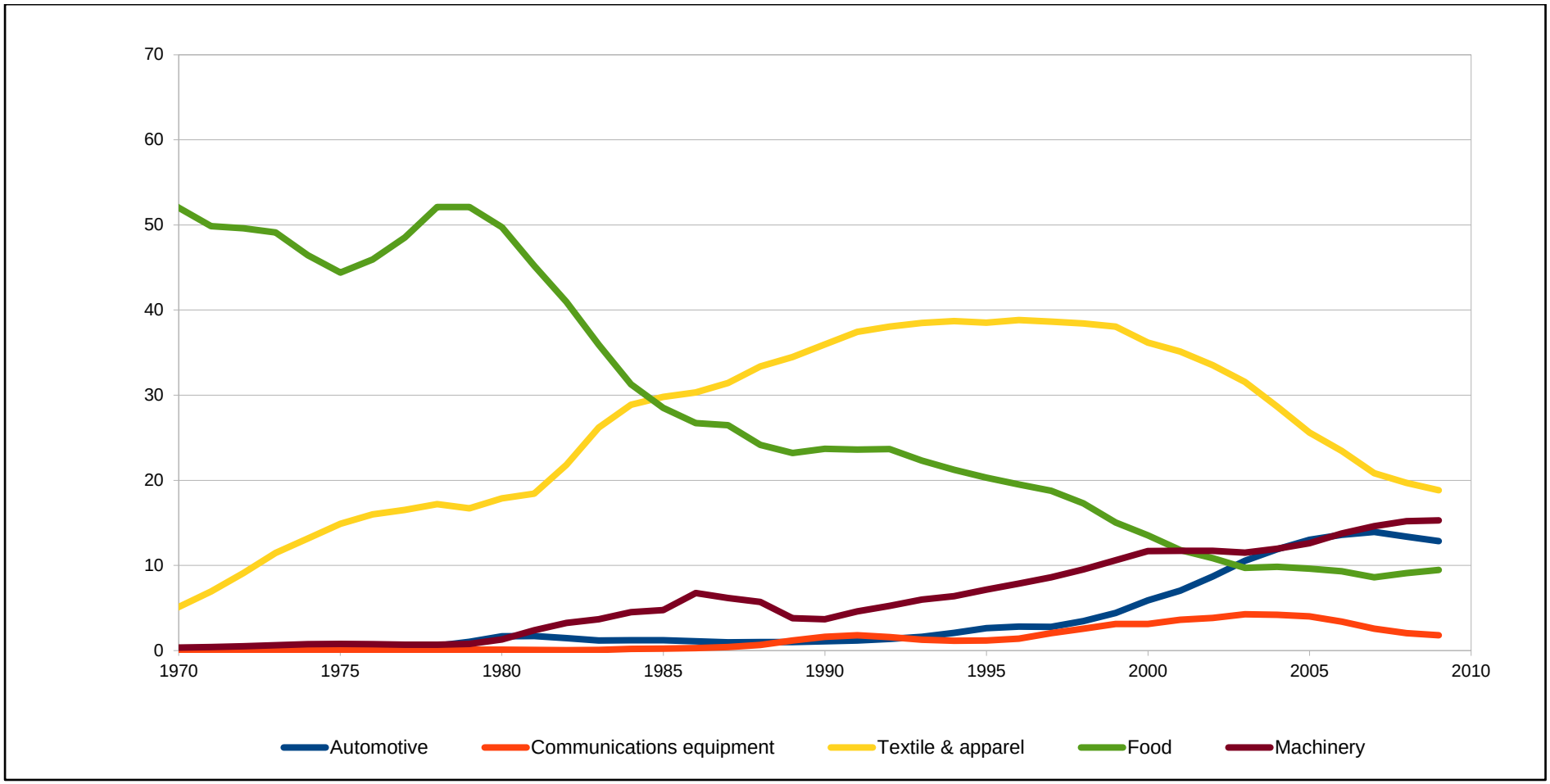
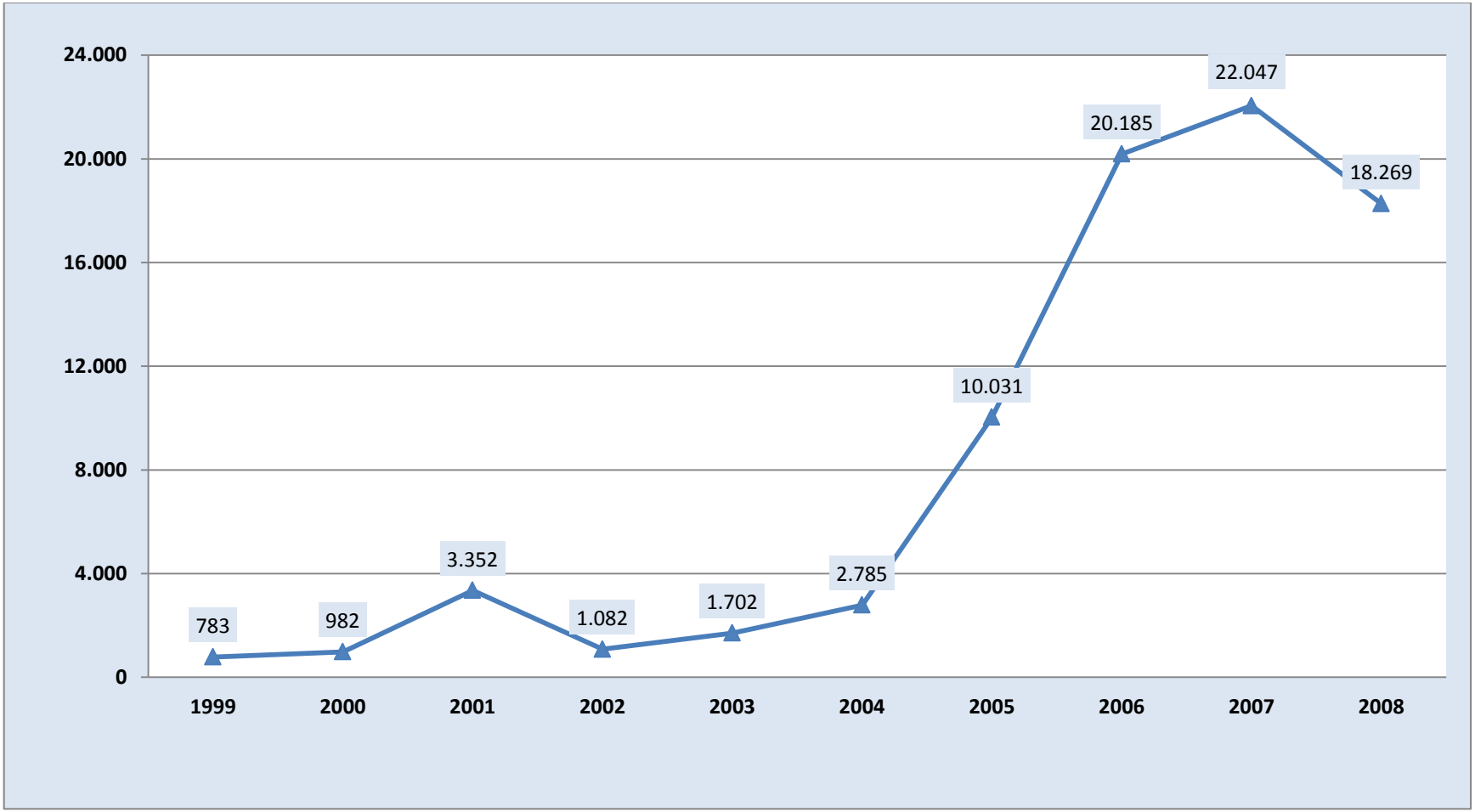
Figure 2.1: Evolution of sector shares in total exports in Turkey: 1970-2009 * (%)



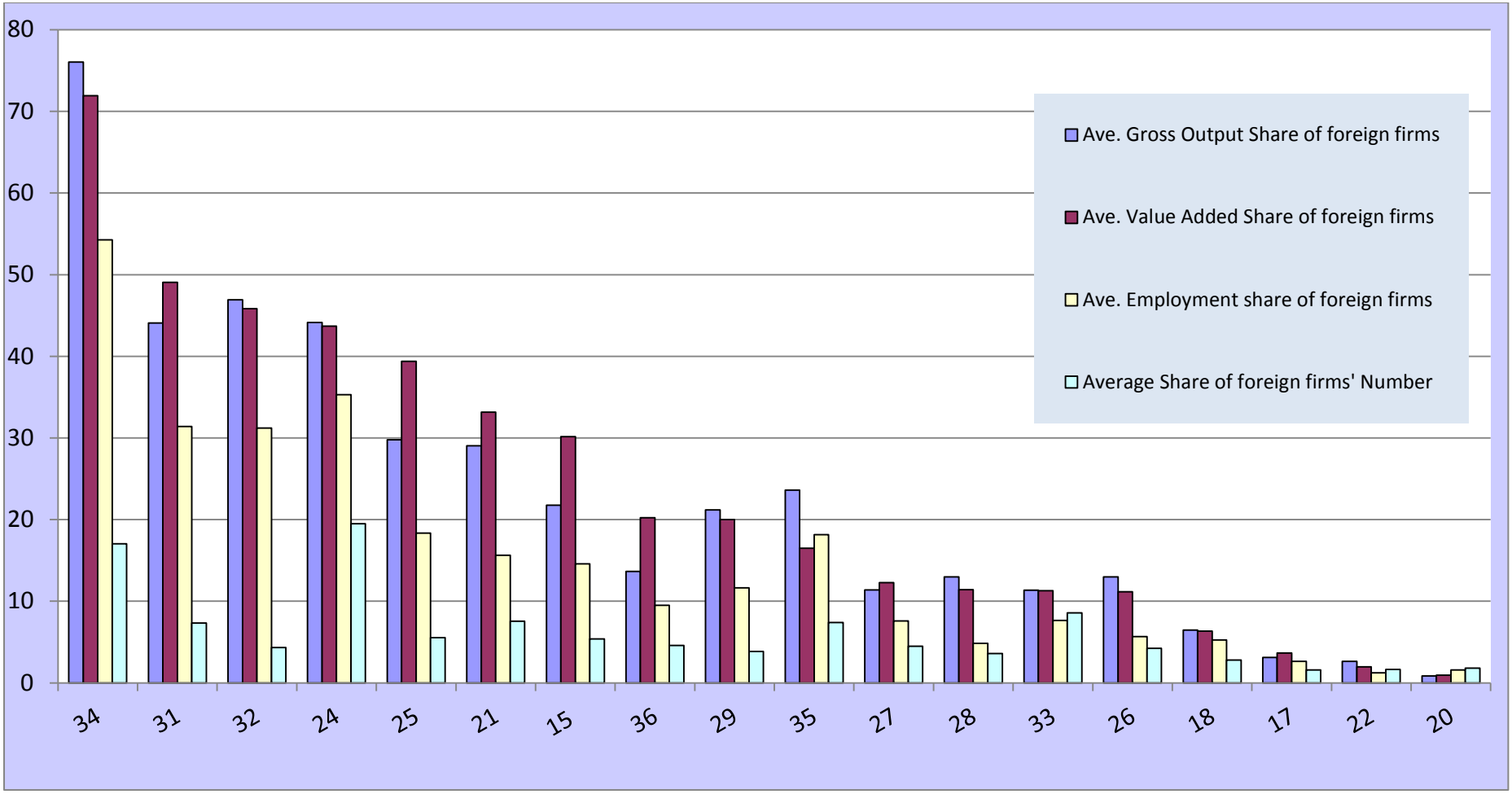
Source: COMTRADE database; *three-year moving averages (*we are grateful to Erol Taymaz for providing us data on exports)*

Figure 2.2: Net FDI inflows in Turkey over 1999-2008 (million dollars)



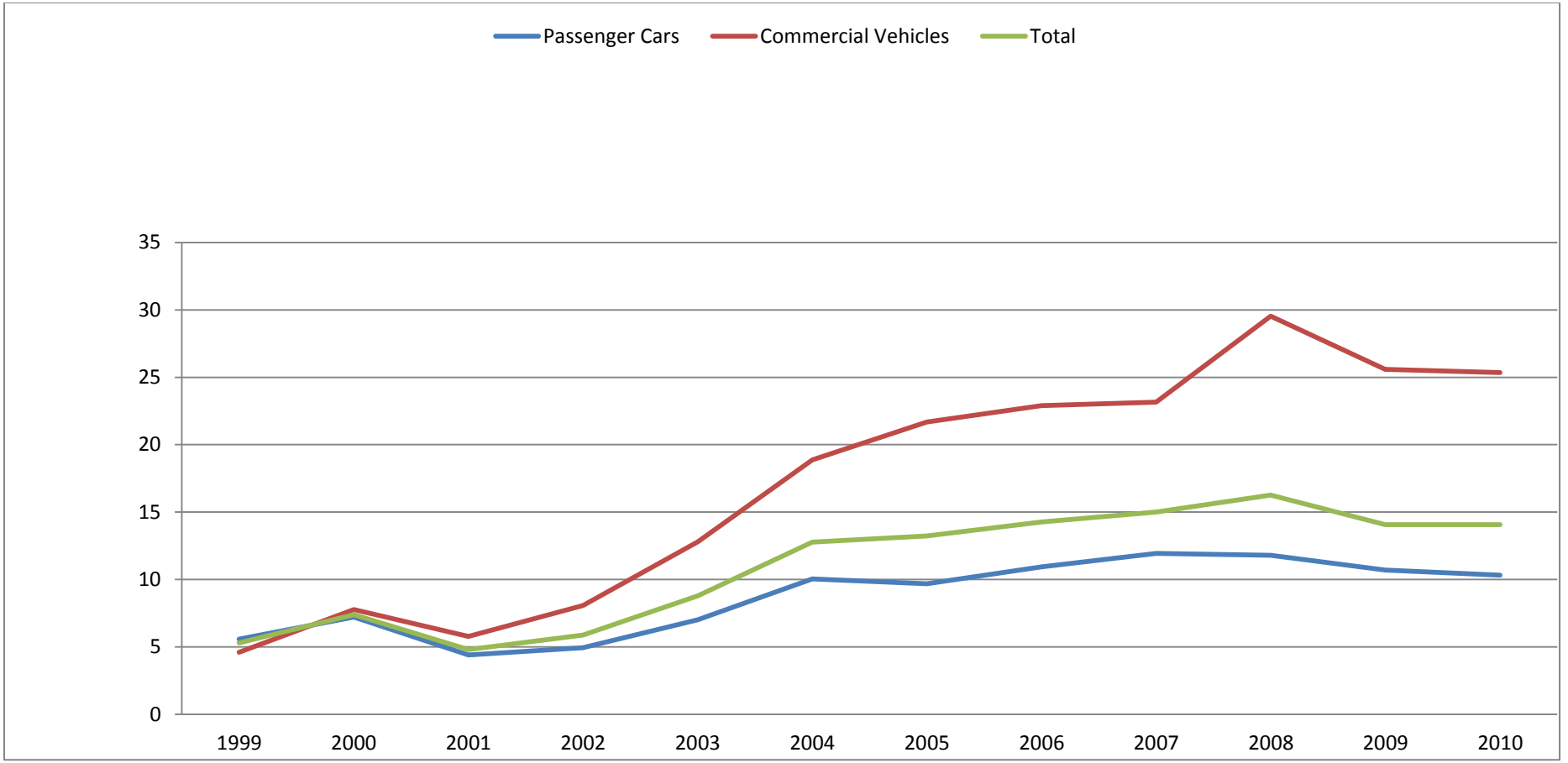
Source: Undersecretariat of Treasury.

Figure 2.3.: Share of foreign firms in production, value added, employment and total number of firms over 2003-2006(%)



Source: authors' calculations from TurkStat's Structural Business Statistics Survey. Figures on the horizontal axis relate to two-digit level NACE sectors.

Figure 2.4: Share of Turkey's Motor Vehicle Production in Total World Production (‰)



Source: The International Organization of Motor Vehicle Manufacturers website (www.**oica**.net)

Table 4.1a: Summary statistics

	Local Firms			Foreign Firms			Direct Supplier Firms			All Firms		
	Obs.	**Mean**	**St. Dev.**	**Obs.**	**Mean**	**St. Dev.**	**Obs.**	**Mean**	**St. Dev.**	**Obs.**	**Mean**	**St. Dev.**
Age (year)	120	28.84	13.78	45	18.56	13.85	132	26.38	14.31	165	26.04	14.50
Turnover (euros)	105	24 636 466	34 028 472	38	48 658 397	56 000 000	114	33 284 149	41 375 000	143	31 019 916	42 176 567
Employment	119	255.33	280.48	42	404.36	551.20	129	325.08	403.91	161	294.20	374.41
Engineer	119	16.38	21.25	42	27.50	26.93	130	22.24	25.06	161	19.42	23.39
White-Collar	119	36.92	33.84	42	67.24	103.87	129	49.05	65.42	161	44.70	61.16
Blue-Collar	118	204.01	245.70	41	318.27	501.69	127	258.24	361.75	159	233.47	333.07
Foreign share (%)	120	0	0	45	76.00	29.10	132	22.00	38.00	165	20.68	37.07
Export intensity (%)	120	34.53	27.50	45	44.00	33.20	133	35.00	28.30	165	36.83	29.41
R&D exp. (euros)	100	456 923	1 814 353	33	1 282 699	2 166 442	107	770 457	2 131 713	133	661 815	1 932 588
R&D intensity (%)	104	2.55	4.83	35	2.91	3.50	111	2.77	4.87	139	2.64	4.52
NPAT	114	3.75	12.59	40	1.62	4.12	125	3.58	12.12	154	3.20	11.05
NOPAT	114	1.56	4.63	40	0.82	2.02	125	1.51	4.48	154	1.37	4.12
NAPAT	112	2.23	8.15	39	0.82	2.22	123	2.10	7.82	151	1.87	7.13
Worktogether (year)	118	18.12	10.29	45	1.,80	11.36	131	18.59	10.85	163	17.48	10.61
Subcontracting agr. (%)	113	13.17	27.55	42	9.00	24.00	125	12.00	27.30	155	12.16	26.61

NOPAT: number of owned patents; NAPAT: number of applied patents; NPAT: number of owned or applied patents: WORKTOGETHER: number of years worked for the most important customer.

Table 4.1b: Alternative indicators of absorptive capacity

	Local	Foreign	DSF	ALL
Share of engineers in total employment (%)	6.79***	11.33***	8,41	7,98
Share of white-collar personnel in total employment (%)	16.6**	20.9**	17,35	17,72
R&D intensity (%)	2,55	2,91	2,77	2,64
Export intensity (%)	34.53*	43.78*	35,30	36,83
# of patents granted	1,56	0,83	1,51	1,37
Sales per employee (euros)	89 159**	159 240**	99 884	107 548

DSF: Direct supplier firms; * , **, *** denote significance at the 10%, 5% and 1 %, respectively.

Table 4.1c: Different levels of design capability

		Local	Foreign	DSF	ALL
Low ↓	**4** All technical specifications, design and quality standards of products are determined by customers	53,0	50	51,2	52,2
	3 Although basic designs are determined by customers, we can add details and/or make joint designing with customer (**co-designer capability**)	61,3	61,4	62,6	61,4
	2 Firm is in charge of all or most of the designing , but customer approval is necessary for final designs	50,4	54,6	53.4*	51,5
High	**1** Our firm is entirely responsible for all stages of product design	30,3	29,6	30,5	30,1
	Obs.	**119**	**44**	**131**	**163**

DSF: Direct supplier firms; * , **, *** denote significance at the 10%, 5% and 1 %, respectively.

Table 4.2: Distribution of suppliers by ownership structure*

		Obs.	%
Local Firms (FS < 10%)		**120**	**72.7**
Foreign Firms (FS ≥ 10%)		**45**	**27.3**
Minority Ownership	(10% ≤ FS ≤ 39%)	3	1,8
Joint Venture	(40% ≤ FS ≤ 69%)	16	9,7
Majority Ownership	(70 % ≤ FS ≤ 99%)	4	2.4
Full Ownership	(FS = 100%)	22	13.3
Total		**165**	**100**

* FS: foreign share defined as the share of foreign partner in firm equity.

Table 4.3: Size distribution of suppliers (%)

	Local		Foreign		DSF		ALL	
	Obs.	%	Obs.	%	Obs.	%	Obs.	%
Employment					*			
10 - 19	2	1.7	1.0	2.4	2.0	1.6	3.0	1.9
20 - 49	9	7.6	2.0	4.8	6.0	4.7	11.0	6.8
50 - 99	22	18.5	10.0	23.8	21.0	16.3	32.0	19.9
100 - 249	41	34.5	9.0	21.4	44.0	34.1	50.0	31.1
250 - 499	34	28.6	10.0	23.8	39.0	30.2	44.0	27.3
500 - 999	8	6.7	6.0	14.3	10.0	7.8	14.0	8.7
1000 +	3	2.5	4.0	9.5	7.0	5.4	7.0	4.3
Total	**119**	**100**	**42**	**100**	**129**	**100**	**161**	**100**

DSF: Direct supplier firms; * , **, *** denote significance at the 10%, 5% and 1 %, respectively.

Table 4.4: Distribution of suppliers by establishment year (%)

	Local		Foreign		DSF		ALL	
	Obs.	%	Obs.	%	Obs.	%	Obs.	%
		***		***				
1930s	1.0	0.8	-	-	1.0	0.8	1.0	0.6
1940s	2.0	1.7	-	-	1.0	0.8	2.0	1.2
1950s	9.0	7.5	1.0	2.2	8.0	6.1	10.0	6.1
1960s	13.0	10.8	2.0	4.4	12.0	9.1	15.0	9.1
1970s	39.0	32.5	13.0	28.9	43.0	32.6	52.0	31.5
1980s	27.0	22.5	4.0	8.9	25.0	18.9	31.0	18.8
1990s	20.0	16.7	9.0	20.0	23.0	17.4	29.0	17.6
2000s	9.0	7.5	16.0	35.6	19.0	14.4	25.0	15.2
Total	**120**	**100**	**45**	**100**	**132**	**100**	**165**	**100**

DSF: Direct supplier firms; * , **, *** denote significance at the 10%, 5% and 1%, respectively.

Table 4.5: Distribution of suppliers by export intensity (%)

	Local		Foreign		DSF		ALL	
	Obs.	%	Obs.	%	Obs.	%	Obs.	%
		*		*				
0	8	6,7	6	13,3	12	9,1	14	8,5
1 - 10	28	23,3	4	8,9	25	18,9	32	19,4
11 - 20	17	14,2	5	11,1	21	15,9	22	13,3
21 - 40	19	15,8	8	17,8	20	15,2	27	16,4
41 - 50	15	12,5	4	8,9	17	12,9	19	11,5
51 - 70	19	15,8	7	15,6	19	14,4	26	15,8
71 - 90	12	10,0	7	15,6	15	11,4	19	11,5
90 -100	2	1,7	4	8,9	3	2,3	6	3,6
Total	**120**	**100**	**45**	**100**	**132**	**100**	**165**	**100**

DSF: Direct supplier firms; * , **, *** denote significance at the 10%, 5% and 1%, respectively.

Table 4.6: Distribution of suppliers by market orientation (%)

Major Markets	Local	Foreign	DSF	ALL
Domestic Market	60,8	51,1	60,6	58,2
European Union†	35,0	42,2	34.9**	37,0
Middle East	1.7*	4.4*	3,0	2,4
Asia	0,8	2,2	0,8	1,2
USA	1,7	0	0.8*	1,2
Africa	0	0	0	0
Other Countries	0	0	0	0
	100	**100**	**100**	**100**

† Germany (23%), France (17%), England (14%), Italy (9%), Spain (7%) and remaining 21 EU members (30%)

Table 4.7: Distribution of suppliers according to the technological complexity of products manufactured (%)

	Local***	Foreign***	DSF***	ALL
High-Technology	45,4	68,9	55,7	51,8
Medium-Technology	35,3	20,0	31,3	31,1
Low-Technology	19,3	11,1	13,0	17,1
Total	**100**	**100**	**100**	**100**

***, **, * denote significance level at 1%, 5% and * 10%, respectively (Mann-Whitney U test, 2-sided).

Table 4.8: Types of knowledge and technology transfers related to the production process (%)

		Often				Sometimes			
		Local	Foreign	DSF	ALL	Local	Foreign	DSF	ALL
1.	**Provided various documentations**	35.8*	24.4*	32,6	**32,7**	55.3*	57.7*	57,6	**56,4**
2.	**Assistance for logistic management**	17.5*	8.9*	15.9*	**15,2**	58.3*	55.5*	59.8*	**57,6**
3.	Assistance for quality control methods	14,2	13,3	13,6	**13,9**	65,0	53,3	64,4	**61,8**
4.	**Provided know-how**	9.3*	13.3*	12,3	**10,4**	50*	62.2*	50,0	**53,4**
5.	**Assistance for R&D activities**	9,2	13,3	11,4	**10,3**	53,3	53,3	54,5	**53,3**
6.	Supply of raw material	10,0	8,9	10,6	**9,7**	29,2	37,8	32,6	**31,5**
7.	Customer sent its staff for assistance in solving problems in the production process	5,8	8,9	7,6	**6,7**	50,0	51,1	50,8	**50,3**
8.	**Assistance for design**	6,7	6,7	8.3**	**6,7**	51,7	62,2	56.8**	**54,5**
9.	Supply of machinery, tools and equipment	4,2	8,9	6,8	**5,5**	40,0	40,0	40,2	**40,0**
10.	Assistance for productivity-related problems	4,2	8,9	6,8	**5,5**	50,8	42,2	49,2	**48,5**
11.	Customer's staff involved in the establishment of production processes of the plant	5,8	4,4	6.8**	**5,5**	29,2	31,1	31.8**	**29,7**
12.	Patent and/or license rights granted	2,5	4,4	3.8**	**3,0**	14,3	13,3	16.7**	**14,0**
13.	Assistance for business management	1,7	4,4	2.2*	**2,4**	30,8	35,6	35.6*	**32,1**

***, **, * denote significance level at 1%, 5% and * 10% respectively (Mann-Whitney U test, 2-sided). Items are sorted according to "all firms" and "often" category. Items denoted in bold are the questions included explicitly in the survey questionnaire. Remaining items were added by the respondents themselves.

Table 4.9: Types of knowledge and technology transfers related to products (%)

	Often				Sometimes			
	Local	Foreign	DSF	ALL	Local	Foreign	DSF	ALL
Technical specifications, original design or technical drawings related to products	55.5***	31.1***	47,0	48,8	31.9***	40***	36,4	34,1
Joint operations related to product	25,2	28,9	27,3	26,2	53,8	57,8	54,5	54,9
Product specifications	27,7	22,2	25,8	26,2	38,7	55,6	43,2	43,3
Joint design activity related to product	15,1	13,3	16.7**	14,6	54,6	60,0	57.6**	56,1
Assistance related to product designs	10,2	15,6	12.2*	11,7	52,5	51,1	55.0*	52,1

***, **, * denote significance level at 1%, 5% and * 10% respectively (Mann-Whitney U test, 2-sided). Items are sorted according to "all firms" and "often" category.

Table 4.10: Knowledge and technology transfers through training: types of training (%)

Types of trainings	Often				Sometimes			
	Local	Foreign	DSF	ALL	Local	Foreign	DSF	ALL
Training on technologies used in production	9,2	15,6	13.0*	11,0	37,0	37,8	38.2*	37,2
Training of production/operation staff (engineers, technicians etc.)	7,6	17,8	13.0**	10,4	53,8	46,7	52.7**	51,8
Training of management staff	5,8	11,1	9.1*	7,3	47,5	53,3	50*	49,1

***, **, * denote significance level at 1%, 5% and * 10% respectively (Mann-Whitney U test, 2-sided). Items are sorted according to “all firms” and “often” category.

Table 4.11: Knowledge and technology transfers through training: modes of training (%)

	Often				Sometimes			
	Local	Foreign	DSF	ALL	Local	Foreign	DSF	ALL
A) Visits to customers’ plants	20,8	13,3	18,9	18,8	60,8	71,1	63,6	63,6
B) Off-the-job training								
(seminars and courses)								
at supplier's plant	47,1	42,2	47,3	45,7	44,5	51,1	46,6	46,3
at other private specialized institutes	20.2**	26.7**	22,1	22,0	64.7**	73.3**	69,5	67,1
at customers’ plants	6.7*	6.7*	6.8*	6,7	61.7*	77.7*	68.9*	66,1
On-the-job training								
(theoretical and/or applied training)								
at costumer's plant								
In Turkey	4,2	4,4	4,5	4,2	35,0	44,4	39,4	37,6
Abroad	1.7**	0**	1,5	1,2	22.0**	40**	29,2	27,0
at supplier's plant	5,9	11,4	8,5	7,4	42,0	38,6	40,8	41,1

***, **, * denote significance level at 1%, 5% and * 10% respectively (Mann-Whitney U test, 2-sided). Items are sorted according to “all firms” and “often” category.

Table 4.12: Financial transfers by customers (%)

	Often				Sometimes			
	Local	**Foreign**	**DSF**	**ALL**	**Local**	**Foreign**	**DSF**	**ALL**
Pre-financing of machinery, equipment and tools	8.6*	17.8*	13.2***	11,1	39.3*	42.2*	44.2***	40,1
Prepayment for orders before delivery	7,6	6,7	7,6	7,3	36,1	31,1	32,1	34,8
Loans with low interest rates	1,7	0,0	1,5	1,2	6,8	2,2	4,6	5,5
Risk capital	0,8	0,0	0,8	0,6	4,2	0,0	3,8	3,1
Unilateral financial aid	0,0	0,0	0,0	0,0	7,7	4,4	7,8	6,8

***, **, * denote significance level at 1%, 5% and * 10% respectively (Mann-Whitney U test, 2-sided). Items are sorted according to “all firms” and “often” category.

Table 4.13: Why do automotive suppliers collaborate with other firms? (%)

		Local	**Foreign**	**DSF**	**ALL**
1.	**Improving product quality**	79,2	77,8	79,5	78,8
2.	**Learning about new technologies**	75.0**	60.0**	72,0	70,9
3.	Opening up to global markets	73.3*	64.4*	72,0	70,9
4.	Entering new technology fields	74.2*	53.3*	67,4	68,5
5.	Reducing/sharing production costs/risks	65,8	53,3	63,6	62,4
6.	**Carrying out R&D activities**	60,8	46,7	56,8	57,0
7.	**Establishing long-term strategic partnership**	52,5	62,2	54,5	55,2
8.	Replacing technologically phased out products with new ones	54,2	44,4	53,0	51,5
9.	**Know-how transfer**	50,8	42,2	50,8	48,5

***, **, * denote significance level at 1%, 5% and * 10% respectively (Mann-Whitney U test, 2-sided).
Responses indicating the degree of importance as being *important* or *very important* are presented here.

Table 4.14: Correlation matrix

	Age	Size	ExpInt	DSF	Foreign	GroupLoc	ClientMNC	R&D	Patents	ISO1696	ShareEng
Age	1										
Size	0.2301*	1									
ExpInt	-0.0023	0.1909*	1								
DSF	-0.0304	-0.2429*	0.1428	1							
Foreign	-0.2985*	0.1146	0.1544	-0.1374	1						
GroupLoc	0.0102	0.2896*	-0.1545	-0.2147*	0.0278	1					
ClientMNC	0.0224	0.1141	0.1081	-0.0739	0.1232	0.0332	1				
R&D	0.1817*	0.2162*	0.1562	-0.1478	-0.0556	0.0478	0.0648	1			
Patents	-0.0364	0.1250	0.0616	-0.0043	0.0023	0.0694	-0.0018	0.2004*	1		
ISO1696	-0.0096	0.3986*	0.1333	-0.2163*	0.1374	0.2387*	0.2126*	-0.0196	-0.0634	1	
ShareEng	-0.1449	-0.2116*	-0.0065	-0.1078	0.2168*	-0.0545	0.1008	0.0340	-0.0407	-0.0866	1

* denotes a correlation coefficient that is significant at the 5 % level.

Table 4.15: Determinants of knowledge and technology transfers related to production process

	Design	R&D	Know-how	Logistic Management	Documentati-ons
Age	-0.01	-0.01	-0.03**	-0.01	-0.002
	(0.01)	*(0.01)*	*(0.01)*	*(0.01)*	*(0.01)*
Firm Size	0.06	0.06	0.001	0.04	0.25
	(0.20)	*(0.20)*	*(0.19)*	*(0.20)*	*(0.20)*
Export	0.01	-0.19	-0.05	-0.02	0.12
	(0.15)	*(0.14)*	*(0.14)*	*(0.14)*	*(0.14)*
Direct Supplier	1.01**	0.52	0.07	1.13**	0.52
	(0.44)	*(0.43)*	*(0.43)*	*(0.45)*	*(0.43)*
Foreign Capital	0.18	0.07	0.42	-0.78*	-0.83**
	(0.40)	*(0.40)*	*(0.40)*	*(0.40)*	*(0.41)*
Local Group	-0.56	-0.07	-0.02	-0.72**	-0.39
	(0.37)	*(0.36)*	*(0.36)*	*(0.37)*	*(0.36)*
MNC among Customers	0.36	-0.16	0.59	0.22	-0.31
	(0.48)	*(0.46)*	*(0.49)*	*(0.47)*	*(0.45)*
R&D Activity	0.80	0.43	0.22	0.40	-0.64
	(0.49)	*(0.48)*	*(0.47)*	*(0.49)*	*(0.49)*
# obs.	151	151	149	151	151

Standard errors are given in parentheses
***, **, * denote significance level at 1%, 5% and * 10% respectively

Table 4.16: Determinants of knowledge and technology transfers related to product:

	Assistance related to product designs	Joint-design activity	Joint-operation	Product specific.	Technical specifications, Original design or Technical drawings
Age	-0.01	0.003	-0.0008	0.008	-0.002
	(0.01)	*(0.01)*	*(0.01)*	*(0.01)*	*(0.01)*
Firm Size	0.14	0.43**	0.04	-0.17	-0.21
	(0.20)	*(0.20)*	*(0.19)*	*(0.18)*	*(0.20)*
Export	0.13	0.28*	0.14	0.01	0.29**
	(0.15)	*(0.15)*	*(0.15)*	*(0.14)*	*(0.14)*
Direct Supplier	0.91**	0.95**	0.50	-0.13	0.32
	(0.46)	*(0.47)*	*(0.43)*	*(0.41)*	*(0.44)*
Foreign Capital	0.18	-0.09	0.33	0.17	-1.16***
	(0.40)	*(0.40)*	*(0.39)*	*(0.37)*	*(0.39)*
Local Group	-0.84**	-0.34	-0.21	0.15	-0.22
	(0.38)	*(0.37)*	*(0.36)*	*(0.34)*	*(0.35)*
MNC among Customers	-0.55	-0.08	0.17	-0.22	-0.23
	(0.48)	*(0.48)*	*(0.47)*	*(0.43)*	*(0.46)*
R&D Activity	0.64	1.00**	-0.07	0.15	-0.65
	(0.49)	*(0.50)*	*(0.49)*	*(0.455)*	*(0.50)*
# obs.	149	150	150	150	150

Standard errors are given in parentheses
***, **, * denote significance level at 1%, 5% and * 10% respectively

Table 4.17 – Determinants of the types of training provided by customers

	Training on technologies used in Production	Training of production staff (engineers, technicians etc.)	Training of managers
Age	0.01	0.003	0.01
	(0.01)	*(0.01)*	*(0.0124)*
Firm Size	0.42**	0.69***	0.26
	(0.20)	*(0.21)*	*(0.198)*
Export	-0.18	-0.13	-0.32**
	(0.15)	*(0.15)*	*(0.15)*
Direct Supplier	0.56	0.75*	0.53
	(0.45)	*(0.43)*	*(0.44)*
Foreign Capital	0.48	0.20	0.58
	(0.40)	*(0.41)*	*(0.40)*
Local Group	0.0004	0.14	0.30
	(0.36)	*(0.36)*	*(0.36)*
MNC among Customers	-0.16	0.10	0.21
	(0.47)	*(0.48)*	*(0.48)*
R&D Activity	-0.64	-0.71	-0.35
	(0.47)	*(0.48)*	*(0.46)*
# obs.	150	150	151

Standard errors are given in parentheses
***, **, * denote significance level at 1%, 5% and * 10% respectively

Table 4.18 – Determinants of financial transfers by customers

	Unilateral Financial Aid	Low-interest loans	Risk Capital	Pre-finance of machinery, equipment and tools	Prepayment for orders before delivery
Age	-0.002	0.04	-0.004	0.003	0.03**
	(0.02)	(0.03)	(0.04)	(0.01)	(0.01)
Firm Size	0.12	1.17**	0.33	0.22	0.36*
	(0.39)	(0.47)	(0.63)	(0.19)	(0.200)
Export	030	-0.47	-0.37	0.09	0.01
	(0.34)	(0.31)	(0.40)	(0.15)	(0.15)
Direct Supplier	1.23	-0.15	16.08	1.23**	-0.70
	(1.14)	(0.84)	(2,47)	(0.49)	(0.44)
Foreign Capital	-0.73	-1.60	-16.70	0.41	0.13
	(0.88)	(1.20)	(2,39)	(0.40)	(0.41)
Local Group	-0.23	-1.84*	0.06	0.19	0.22
	(0.70)	(0.94)	(1.00)	(0.356)	(0.37)
MNC among Customers	-0.52	1.17	16.3	-0.16	-0.90*
	(0.85)	(1.16)	(2,96)	(0.47)	(0.48)
R&D Activity	0.27	-1.26	0.05	-0.55	-0.30
	(1.16)	(0.89)	(1.33)	(0.500)	(0.48)
# obs.	148	149	149	148	151

Standard errors are given in parentheses below the coefficient estimates
***, **, * denote significance level at 1%, 5% and * 10% respectively

Table 4.19 – Determinants of inter-firm cooperation activities (Why do suppliers cooperate with other firms?):

	Carrying out R&D activities	Know-how transfer	Establishing long-term strategic partnership	Improving product quality	Learning about new technologies
Age	-0.01	0.01	-0.02*	-0.03**	-0.03***
	(0.01)	*(0.01)*	*(0.01)*	*(0.0)*	*(0.0127)*
Firm Size	0.18	0.10	0.39**	0.33*	0.23
	(0.18)	*(0.18)*	*(0.19)*	*(0.19)*	*(0.18)*
Export	-0.14	-0.16	-0.27*	-0.15	-0.08
	(0.13)	*(0.14)*	*(0.14)*	*(0.14)*	*(0.14)*
Direct Supplier	-0.13	0.52	-1.14***	-0.16	-0.062
	(0.42)	*(0.44)*	*(0.44)*	*(0.43)*	*(0.435)*
Foreign Capital	-0.60	-0.69*	-0.09	-1.24***	-1.30***
	(0.38)	*(0.37)*	*(0.38)*	*(0.395)*	*(0.383)*
Local Group	0.44	0.39	0.24	-0.09	-0.15
	(0.35)	*(0.35)*	*(0.34)*	*(0.36)*	*(0.35)*
MNC among Customers	-0.34	-0.79*	0.01	-0.27	0.21
	(0.46)	*(0.47)*	*(0.45)*	*(0.45)*	*(0.47)*
R&D Activity	1.48***	0.50	1.54***	1.67***	1.37***
	(0.47)	(0.45)	(0.47)	(0.45)	(0.451)
# obs.	139	137	138	144	143

Standard errors are given in parentheses
***, **, * denote significance level at 1%, 5% and * 10% respectively

Table 5.1: Determinants of different types of KTTs: recapitulative table*

	Transfers related to Production Process	Transfers related to Product	Training	Financial Transfers	Cooperation Activities
Age	- Know-how			+ Prepay for orders before delivery	- Long-Term Strategic Partnership - Improve Product Quality - Learn about New Technologies
Firm Size		+ Joint design activities	+ Training of production staff	+ Low Interest Loans + Prepay for orders before delivery	+ Long-Term Strategic Partnership + Improve Product Quality
Export		+ Joint design act. + Technical specifications, original design or technical drawings	- Training of management staff		- Long-Term Strategic Partnership
Direct Supplier	+ Design + Logistic	+ Design + Joint design activities	+ Training of production staff	+ Pre-Finance of Machine, Equipment and Tools	- Long-Term Strategic Partnership
Foreign Capital	- Document. - Logistic	- Technical specifications, original design or technical drawings			- Know-how transfer - Improve Product Quality - Learn about New Technologies
Local Group	- Logistic	- Design		- Low Interest Loans	
MNC among Customers				- Prepay for orders before delivery	- Know-how transfer
R&D Activities		+ Joint design activities			+ R&D cooperation + Long-Term Strategic Partnership + Improving Product Quality + Learn about New Technologies

* (+) : Positive Effect and (-): Negative Effect, statistically significant at least at the 10% level.