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Industrial Clustering, Innovation and Competitive Advantage in the Metropolitan Regions: Evidence from the Auto-parts Cluster within the Tehran Metropolitan Region

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Abstract:

This paper explores the empirical evidence of the nature of intra-metropolitan supply linkages and industrial clustering and searches for the driving forces that enhances the learning processes and innovation capacities hence; contributing to competitive advantage within the Tehran metropolitan. The research points to accelerating growth in the automotive sector since the late 1980s and early 1990s which has been the driving force of the Tehran's economy. This growth appears to be related to industrial clustering and systemic linkages with actors such as suppliers, sub-contractors and so on. The analysis of empirical evidences from the sample industrial cluster indicates a considerable number of interesting findings from strong degrees of industrial clustering. However, there are some weak evidences of industrial clustering such as weak institutional environment in the cluster.

Keywords: Industrial clustering, Learning, Innovation, Competitive advantage

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1. Introduction

Regionalization is increasingly viewed as one important aspect of the globalization process. The principal empirical sign of the trend towards regionalization is the apparent growth in the importance of industrial clusters over the past few decades. Since the 1970s, different types of industrial clusters have established a strong position in world markets for both traditional products (e.g. Third Italy) and high technology products (e.g. Silicon Valley) (Isaksen 2001). This has led leading researchers and policymakers to observe that 'in a global economy which boasts rapid transportation, high-speed communication and accessible markets, one would expect location to diminish in importance. But the opposite is also true. The enduring competitive advantages in a global economy are often local, arising from concentrations of highly specialized skills and knowledge, institutions, rivals, related businesses, and sophisticated customers(Porter 1998, p.90). Thus, today's economic map of the world is dominated by… cluster: critical masses-in one place-of unusual competitive success in particular field' (Porter 1998: 78). Therefore, despite economic pressures for globalization, many industrial clusters are still tightly connected with localized geographical features (Donggang et al. 2005). From this view, the capacity of industrial clusters to support processes of learning and innovation has been identified as a key source of competitive advantage in regional economic development (MacKinnon, Cumbers, and Chapman 2002: 294). Bearing these in mind, this paper explores the empirical evidence of the nature of intra-metropolitan vertical and horizontal linkages and clustering and searches for the driving forces that enhance the learning processes and innovation capacities that contribute to competitive advantage within the Tehran Metropolitan Region (TMR). The paper is followed in the five sections. In section two, a theoretical framework on industrial clustering is presented. In section three, research methodology is discussed. In section four, the profile of metropolitan economy and growth of the auto-parts cluster in Tehran metropolitan is briefly described. In section five, the results of the research is analysed and finally some conclusions are drawn of the extent of industrial clustering in auto-parts cluster.

2. Theoretical framework

A considerable body of work is built up on the theoretical dimensions of industrial clustering (Lundequist and Power, 2002, Porter, 1998, Porter, 2000, Baptista, 2001, Simmie, 2004, Sternberg and Litzenberger, 2004), making it clear that the industrial cluster concept, both in theory and practice is quite slippery and hard to categorically define. However, it is important to examine how these 'clusters' operate and

develop if we are to better understand how the concept has an effect on metropolitan development processes(Lundequist and Power, 2002). Thus, in the literature, clusters are defined as a geographical concentration of firms which exhibit a significant degree of intra-metropolitan linkages. Industry clusters are agglomerations of competing and collaborating industries in a region networked into horizontal and vertical relationships, involving strong vertical backward and forward linkages, and relying on a shared foundation of specialised institutions and helping drive the region's economic development (Wever and Stam, 1999). Industrial clusters can develop either around large firms through outsourcing and the local establishment of suppliers, services and customers, as a network of small and medium-sized firms characterized by vertical or horizontal cooperation, or around universities and research institutes through direct or indirect spin-offs (Matuschewski, 2006, Markusen, 1996, Porter, 1998, Enright, 2003). At the same time, the presence of one or several 'leading firms in the same cluster may also influence the diffusion of innovation to other firms in the region because a lead firm is likely itself to employ state-of-the-art technology, possibly generating knowledge spillovers, subcontracting and so on with other firms (Harrison et al., 1996, Lyons, 2000). A cluster unites firms from different levels in the industrial chain (Suppliers, Customers), with service units (financial institutions, production-supporting services) and with government bodies, universities, research institutes etc. What types of local links and networks may then exist which contribute to the development of industrial clustering in a metropolitan environment? The literature on industrial clustering suggests that metropolitan labour market and spin-offs, forward and backward linkages, knowledge transfer or spillovers, inter-firm cooperation and competition, and institutional environment are the most important elements contributing to the competitiveness, learning and innovation of industrial clusters. One of the most important elements in industrial clustering is labour market pooling and spin-off through employees. Labour mobility is a basic factor in the recombination of existing information and in the generation of a common information pool within a regional environment (Antonelli, 2000). It is argued that labour mobility is among the most important channels for transfer of learning, which act as a key externality for firms in a given industry. Clusters should also develop and draw on a strong common pool of labour, so that a supply of agglomeration-specific skills and tacit knowledge is available to firms, which is as one of the fundamental conditions necessary for the development of industrial clusters (Scott, 1998, Keeble and

Nachum, 1999). Search and transaction costs in recruiting employees are likely to be lower and a more efficient matching of jobs and people may be possible (Porter, 1998). Moreover, in a stronger industrial cluster, employees or engineers may leave larger firms to create their own businesses. This trickle-down effect of new firms tends to complement or compete with existing firms, which in turn stimulates learning and innovation processes and cluster growth. Thus, three key mechanisms of learning and innovation can be resulted relating to the extent of local spin-off from existing firms through the formation of new firms, the level of inter-firm interaction, and flows of skilled personal between firms (Keeble et al., 1999A).

In addition, vertical backward and forward linkage is also regarded as another important characteristic of the industrial clustering (Harrison, 1992). A major argument of this phenomenon is that the combination of scale economies and transportation costs encourages the users and suppliers of intermediate inputs to cluster near each other (Krugman, 1995). In fact, close vertical linkages between a supplier and a buyer may guarantee on time delivery of inputs, and may also be a guarantee for the quality of the inputs and a relatively fast diffusion of learning and new innovation (Hoen, 2002). Such proximity allows firms to replace internal supply by external supply, while avoiding the high transaction costs which may be incurred when such linkages are implemented at a distance. Porter (Porter, 1998) discusses that location within a cluster can provide lower cost access to specialised inputs such as components, machinery, business services, and personnel relations compared to vertical integration, importing inputs from distant locations. on the strength of these linkages, firms in a environment may be able to learn how to develop collective and cumulative learning processes that allow them to compete in more and more activities (O'Sullivan, 2000). There is another point that this cluster structure, consisting of firms that produce the same or similar goods and services at a specific level in the value chain. Thus, these firms may formally or informally collaborate to develop innovations in pro-competitive or strategic alliances. While there must be rivalry among firms in order to create competitive advantage, and encourage constant innovation and enhance learning capacities, the literature on industrial clusters suggests that informal, face-to-face, oral relationship is critical to the innovation and learning process (Saxenian, 1994). At the same time, they can become the basis of rich information exchange network that enables firms to learn about new alliance and market opportunities with reliable partners(Powell et al., 1996). The development and gradual building of such networks and social capital

implies a degree of mutual trust among industry clusters .

The institutional environment has also an impact on the intensity and nature of interaction firms and other actors in the region such as exchange of knowledge between firms and universities and capital flows between firms and financial institutes (Saviotti, 1996, Boschma, 1999). Industrial clusters in the proximity of the metropolitan area especially benefit from the favourable institutional environment to access the diverse learning bases and create various new opportunities of interaction. In such an environment, innovation results as the output of a diffused and collective process where different knowledge bases are absorbed, recombined and shared through diverse communication channels, learning by interacting emerges as the crucial mechanism to effectively build up the collective character of knowledge, in turn ensuring innovation (Patrucco, 2003). Thus, metropolitan institutional environment can enhance firms' innovation and consequently upgrade their competitive advantage. Examples of metropolitan institutions include universities, research institutes, vocational training centres, engineering institutes, and industrial and professional associations and so on. These institutions can provide the clustered firms with new learning resources that would be otherwise impossible or much more difficult for firms to access and can have a positive role to play in promoting learning and innovation, especially with respect to small and medium-sized firms (Molina-Morales, 2005). As a result, firms can take advantage of having networks of ties with local institutions that provide a feasible source of information on the options available to enhance the firms' capabilities. In different environments, some authors have provided some evidence of the impact of institutional environment on learning and innovation of firms in industrial clusters. For example, Almeida and Kogut (Almeida and Kogut, 1999) investigated how the relationships among firms, universities, scientists and engineers strongly affects specific local institutions. Swan and Newell (Swan and Newell, 1995) found evidence of the positive effect of the role played by professional associations in the diffusion of innovation. Keeping these in mind, the overall aim of the paper is to assess the extent and nature of industrial clustering and the embeddedness of firms with other actors in the metropolitan environment. Implicit in this approach is a search for the driving forces that enhance competitive advantage, which are learning processes and innovation capacities within the Tehran metropolitan region. In other words, the paper will address the question whether embedded relation in metropolitan region are an important element for explaining competitive advantage, learning process and

innovation of industrial clusters. Notably, to what extent, then, do metropolitan industrial clusters interact with one another and what types of intra-metropolitan linkages may exist which contribute to the development of industrial clustering in a metropolitan environment? What difference exists in the clustering process of firms of different sizes in the auto-parts cluster?

3. Methodology

To achieve the above- mentioned purpose and questions, firms from different categories and sizes are included in the field study. Many case studies and empirical findings about industrial clusters are based on quantitative approaches using statistical analysis to prove the existence of regional relations and their correlation with selected firm characteristics (Matuschewski, 2006) while cluster-based methodology is incomplete without qualitative analysis (Waits, 2000). Thus, the method of research chosen for this study was survey research. A questionnaire survey is an effective method to collect information regarding the characteristics of sampled firms in an industry cluster. In order to select the representative firms for the industry cluster, the necessary information was obtained from different sources in the region. Stratified random sampling was applied for realistically selecting the firms that constituted the industrial cluster. Information received was combined to achieve the most representative sample of firms. Thus, at least 81 firms in auto-parts cluster was identified and asked for an interview. After many phone calls, a total of 30 firms accepted our invitation to participate in an on-site interview where the response rate was about 35%. The present study was carried out from firms clustered in the axis of Tehran-Karaj (Map:1). Data were collected through interviews to map out the importance of networks and degree of industrial clustering, linkages, local labour market, inter-firm cooperation, learning and innovation sources and the institutional context. In addition, expert interviews representing the networking and institutional environment of the cluster (11 interviews) were undertaken with some members of the industrial association of auto-parts manufacturers (3 interviews), some experts (2 interviews) and managing directors (6 interviews) of the automotive components sector. Data storage, management and analysis were achieved using SPSS software version 14.

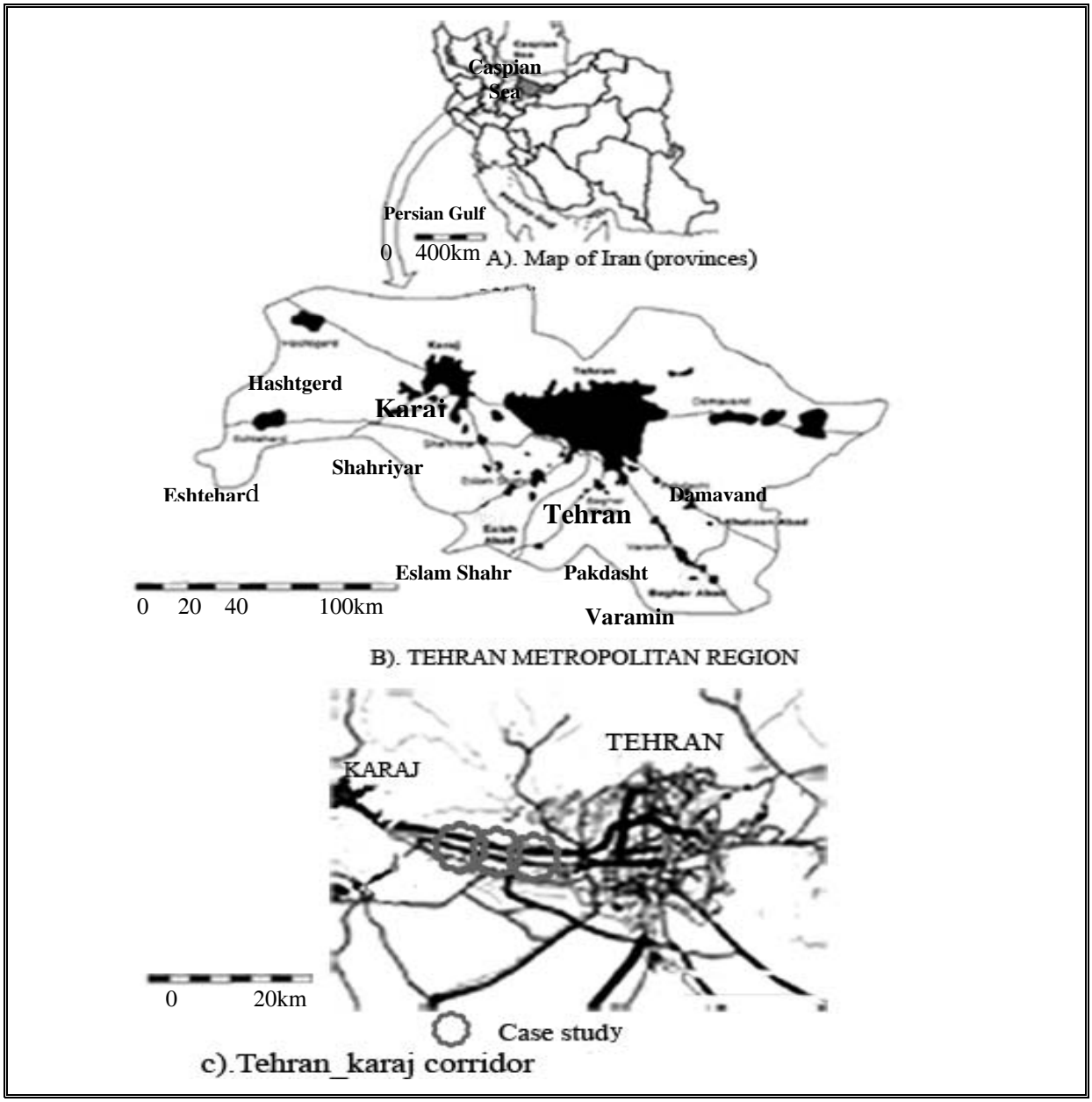
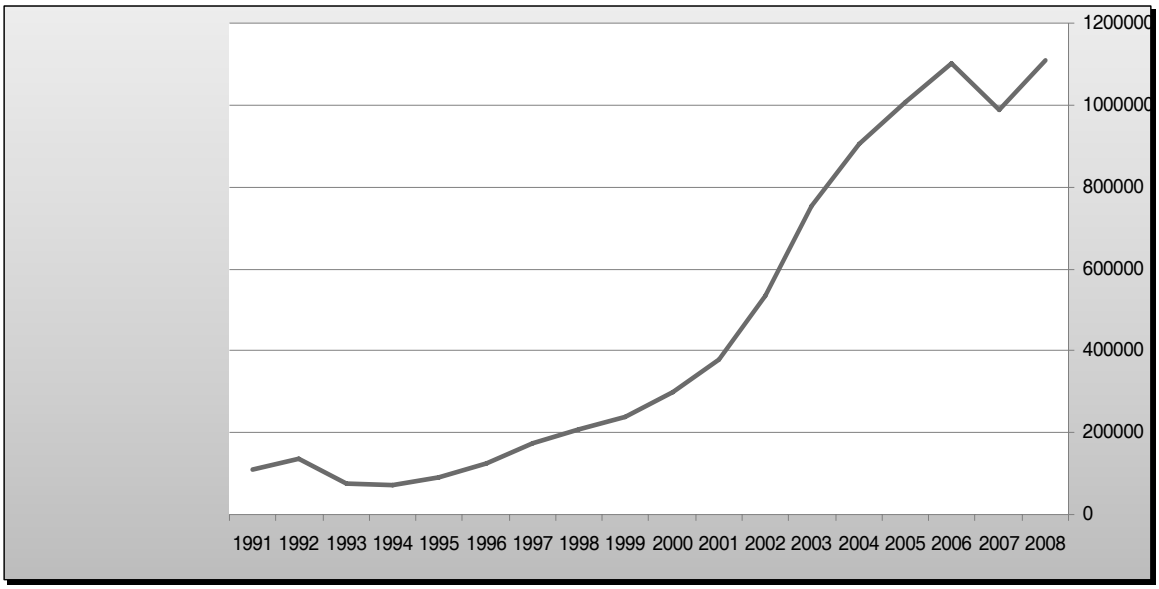


Figure 1: Location of the case study in the Tehran Metropolitan Region

4. Tehran Metropolitan Economy and Growth of the Auto-parts industry cluster

Tehran metropolitan region (as the capital of Iran) is currently the largest concentration of economic activities and the largest market in the country. It has a population of about 13 million which is the most densely populated city of Iran and its contribution of GDP is about 25%. Today, Tehran has about one-third of the share of industry, the number of employees and their value added of the manufacturing industries which shows the importance of

Tehran as the biggest industrial pole in the country. Amongst, the automotive industry has been the fastest growing industry of Iran in the last two decades and currently forms the backbone of the Tehran metropolitan region which alone contributes to almost 43% of the total value and 21.20% employment (S.C.IRIB, 2005) and 4 percent of GDP. The beginning of the cluster would be traced back to the early 1959. During 1960s a trend was started in Iran to establish assembly lines for various cars, buses and trucks concentrating in Tehran but there accelerated the growth and the emergence of a considerable number of small and medium-size firms which were engaged in auto-part manufacturing were since the late 1980s and early 1990, especially when the Iranian Parliament passed 'the National Vehicle Act' in 1993 in order to develop of automotive industry as the locomotive of economic development in Iran(Dadashpoor, 2006). Since then, the sector has been appeared to be driving force of the Tehran metropolitan region. While in 1993 about 71000 vehicles were manufactured in Iran, this figure increased to 1,108,150 in 2005 (Figure 2) with gross output value estimated at about US$12 billion (Business Monitor International, 2008) which shows on average, an increase of about 28% per year. In this industry, most production occurs in the two state-controlled automotive leading companies, Saipa, which accounted for about 54% of the market share for passenger cars and light and heavy vehicles and IranKhodro about 46% of the market in 2008.



Source: Ministry of Industry and Mine, 2009

Figure 2: The growth of automotive industry in Iran between 1993 and 2008

It is estimated that there are more than 1200 auto-parts suppliers in Iran, about 20% of them are situated in Tehran metropolitan region (IRNA news agency, 2005). Production value of automotive components in Iran was about 7 (or 70 thousands billion RL) billion US dollars in 2008 (cited by the Executive of the Association of Auto- Parts). These local networks of suppliers are mainly concentrated on nearby of the two leading companies Irankhodro (ICKO) and Saipa Group, in western corridor of TMR and some other companies which mostly assemblies some products of Mazda, Isuzu and recently Mitsubishi.

5. Results

5.1. Characteristics of the auto-parts cluster

The survey results from general characteristics of the sample industrial clusters indicate that most of the firms were privately-owned even though a small minority of firms were public or state-oriented (18%). The vast majority of the firms (about 61%) were established prior to 1990 when the automotive sector started its remarkable growth. The oldest firm in the sample was established in 1961, assembling Jeeps and commercial trucks (Moeini, 1998). The average firm had 102 employees in 2000, which increased to 234 employees in 2004, with firms ranging in size from 27 to 985 employees. About 22% of firms were small-sized, employing less than 50 employees. 39% of firms employed between 50 and 249 employees and 39% of firms had more than 249 employees. This indicates that the cluster is currently dominated by small and medium-sized firms with some of the large firms (about 39%) in the auto-parts cluster. The average age of the firms in the sample was 17 years, which reflects a roughly young and emerging cluster in the Tehran metropolitan region. Nearly all firms functioned as a sub-contractor for automotive manufacturers in the region.

5.2. The Metropolitan Labour Market and Spin-offs

Generally, metropolitan labour market are characterised by a concentration of skilled people who move from one firm to another and thus become an important channel for learning and one of the most important means of knowledge circulation and information within the cluster (Pietrobelli and Rabellotti, 2004, Saxenian, 1994). The survey shows that inter-firm labour force mobility in the cluster is high and occurs predominantly amongst the skilled labour force and engineers rather than executive employees which is regarded to accumulate the transfer of information and technology spillovers to the auto-parts firms. Labour mobility amongst firms occurs very often (39%) and often (21%) for 65% of firms. For 14% of them inter-firm labour mobility was average.

For the remaining 11% of the firms, labour mobility between firms was rare. There was statistically significant difference between the size of firms and inter-firm labour mobility (Table 3). Most of the inter-firm labour mobility occurs amongst the skilled labour force, technicians and engineers rather than with the administrative labour force because the wages of the latter are stable while engineers can command higher wages depending on their experience and knowledge.

Table 3 Inter-firm labour mobility in Auto-parts cluster

Inter-firm labour mobility	Size of firms							
	<49		50-249		>249		total	
	no.	%	no.	%	no.	%	no.	%
Very often	2	33	3	27	6	55	11	39
Often	2	33	3	27	1	9	6	21
Average	0	0	3	27	1	9	4	14
Little	1	17	2	18	3	27	3	11
Not at all	1	17	1	9	2	18	4	14
Total	5	100	11	100	11	100	28	100

Source: Calculated by authors

Note: Note: Cross-Tabs/ Kendall's-Tau-b: 2.137; p<0.033

In addition, many suppliers have been set up by new firm spin-offs from local existing firms and acted as sub-contractors or had an informal relationship with their parent firms what should be considered as one of the important advantages of clustering in the auto-parts cluster. It is remarkable to observe that the majority of firms (82%) state that some of employees left to set up their own firms in the region, which implies that the rate of formation of new firm spin-offs by other existing firms is intense in the cluster. Thus, it is of great value for these suppliers being linked with their parent firms in close proximity (Pinch and Henry, 1999). Large firms generated stronger sub-contracting networks through their previous employees than had small and medium-sized firms while there was also a statistically significant difference (<0.05%) between the size of firms and the creation of sub-contracting relationships with spin-off firms at the level <0.05%. Moreover, the availability of skilled labour and engineers in the region is high and the firms in the sample met their needs from the metropolitan labour market either from the employees of other local firms or new

employees and engineers who are trained in the local universities and other institutes in the region. The survey of the responding firms reveals that the availability of skilled labour force for about 88% of firms was very easy or easy. The survey showed that the difficulty in finding labour was mainly restricted to skilled engineers for 25% of the responding firms.

5.3. Backward and forward Linkages:

The theoretical literature indicates that strong backward and forward linkages have positive effects for competitiveness and the learning process of industrial clusters. The spatial proximity of suppliers facilitates the exchange of information and promotes a continuous exchange of ideas and innovations, lower transaction costs and boost external economies. Keeping this in mind, a very large number of firms (93%) sourced at least 51% their raw materials locally, followed by 79% of firms which purchased about 23% of their raw materials abroad. Also about 68% of firms relied on the rest of Iran for as much as 18% of their raw materials. The remaining 36% of firms sourced at least 8% of the raw materials from within a 120km radius or neighbouring provinces, which suggests a high dependency of the auto-parts firms on the economy of Tehran metropolitan region (Table 4). There was a statistically significant difference between size of firms and the supply of raw materials from Tehran and abroad at the level of p-value <0.05, which means that small and medium-sized firms mainly sourced their raw materials locally rather than from national and global sources. By contrast, large firms purchased raw materials from abroad more than did small and medium-sized firms.

Table .4. Backward linkages of firms in Auto-parts cluster

Type of supply	% Firms which source from								Average % of supply of firms from				
	Tehran		120km		national		abroad		Tehran	120km	national	abroad	total
	no	%	no	%	no	%	no	%	%				
Raw materials	26	93	10	36	19	68	22	79	51	8	18	23	28
Components	26	93	9	32	15	54	9	32	78	5	9	7	28
New Machinery	21	91	3	11	9	39	20	87	38	2	5	55	23
Second-hand mach	9	75	2	17	2	17	9	75	41	3	4	48	12
Overall Average		88		24		45		68	53	5	9	33	

Source: Calculated by authors

Note: Multiple response were possible

1. Kruskal-Wallis test for raw material: (df: 2; P< 0.05 for Tehran); (df:2; p=0.709 for 120 km); (df:2, P=290 for rest of Iran); (df:2, P= 0.065 for abroad)

2. Kruskal-Wallis test for components: (df: 2; p=0.116 for Tehran); (df:2, p=0.478 for 120km); (df:2, p=0.093 for rest of Iran); (df:2; p<0.05 for abroad)

3. Kruskal-Wallis test for new machinery: (df: 2; p=0.074 for Tehran); (df:2,p=0.752 for 120km); (df: 2, P=0.752 for rest of Iran); (df: 2, P=0.183)

Unlike raw materials, a substantial proportion of firms (93%) sourced at least 78% of the components and parts from metropolitan suppliers while only 32% of firms purchased about 7% of components from abroad. In addition, 32% of firms obtained as much as 9% of the components domestically while some firms (about32%) obtained 5% of the components from within a 120km radius of Tehran. In detail, the survey indicates that more than 68% of firms supplied as much as 70% of their components from Tehran while only 1 firm supplied more than 70% of the components from abroad. National suppliers were not the case in this regard. This shows that the vast majority of firms depend upon metropolitan suppliers and sub-contractors reflecting the presence of the extensive network of part-makers in the region and thereby their interaction for learning and innovation. There was, statistically, significant difference between the size of firms and the supply of components in the case national suppliers at the p level of <0.1% while statistically differences were significant between size of firms and the supply of components from abroad at p value of 0.05%. This analysis suggests that small firms were more embedded into the Tehran economy than were large and even medium-sized firms while large firms sourced from national suppliers and foreign firms much more than did small and medium-sized firms.

Furthermore, Table 4 also indicates that 21 out of 23 firms (91%) which had purchased new machinery and equipment in the last 5 years, 38% of them had supplied from metropolitan suppliers while 87% of firms had sourced about 55% their machines and equipments from global companies, followed by 39% firms, which had supplied more than 70% of the new machinery nationally. The survey shows that 6 out of 23 firms had sourced more than two thirds of their machinery from Tehran while it was 12 out of 23 (52%) of firms which had purchased more than 70% of the new machinery and equipments abroad. This shows that the vast majority of firms were more dependent on both local and global sources for the supply of machinery and equipment. However, most of technically advanced equipments were not available locally and even nationally and firms were far more reliant on global sources. Here there was a statistically significant difference between size of firms and the supply of new machinery and equipments locally and globally at p-value of <0.05% level, implying that small and medium-sized firms more depend on metropolitan region for the supply of new machinery and equipments than were large firms while large firms and even medium-sized firm source at least a part of their new machinery and equipment from abroad much more than small firms do.

In addition, in the auto-parts cluster, nearly all firms have specialised in particular stages of the value chain. Subcontracting is a major feature of this cluster. Thus, a large number of the firms in the cluster subcontract-out some aspects of their production those mainly non-core operations. To confirm this, each of the firms in the sample had on average about 45 subcontracting firms while they acted as subcontractor for 4 firms, of which nearly 90% of that went to just two leading automotive manufacturing companies in the region. Therefore, it seems that the degree of division of labour among firms is extremely high in the auto-parts cluster, indicating a strong vertical inter-firm linkages within the region. Firms were also asked about the destinations of their outputs. The interviewed firms indicate that 100% firms sent as much as 93% of their outputs to a few leading and large companies located in the region where almost all the main passenger and business cars companies are located in a hub and other suppliers and subcontractors are concentrated in their surrounding areas as a "spoke". 25% of firms also sold about 5% of their products to other suppliers in other regions. Only a very tiny share of the outputs (1.4%) of 6 firms was exported abroad (Table5).

Table 5 The share of the destination of final market sales in Auto-parts cluster

Proportion of output Sold on	no and % firms which sell to		average % of sale of firms to
	no	%	%
Within metropolitan (local companies)	28	100	93
120km/ neighbouring provinces	2	7	.60
National market	7	25	5
Global market	6	21	1.4
Total	28		100

Source: Calculated by authors

Note: Multiple response were possible

Kruskal-Wallis test: (df:2, p=0.751 for Tehran); (df:2, p=0.451); (df:2, p=0.109); (df:2, p<.05)

5.4. Learning and Innovation foundations of the cluster

Firms in the cluster show remarkable innovative behaviour either in product or process innovation. 89% of the responding firms had introduced some product or process innovation in the last 3 years and 93% had some ideas and information for innovation. Statistical testing

showed that medium and large firms had more product or process innovation than do small firms (p-value of <0.1). As much as 50% of firms reported that technical innovations had been developed in-house and more than 85% of firms had successfully adopted the design supplied by others. Most the interviewed firms stated that their clients were an effective factor in design changes. 43% of firms believed that cooperation with other local firms had affected their innovation and 36% also declared that cooperation with local universities and university staffs have assisted them in learning about innovation processes. Only 25% of the firms reported that they produced under licence of foreign companies. Lastly, 18% of responding firms had purchased technical knowledge from either international or national sources. The survey also suggests that the majority of firms undertook reverse engineering or imitated the designs from foreign catalogues supplied by local customers. Thus, unsurprisingly, 75% of the firms reported that the development of some of their products were undertaken using reverse engineering. This is confirmed by some studies about industrial regions showing that the main sources of innovation in these regions are 'imitation' and 'practicing ideas developed by leading firms' (Eraydin and Armatli-Köroğlu, 2005). Only 14% of firms had developed some of their products through cooperation with other metropolitan engineering institutes (Table 6). Statistical test shows that large and then medium-sized firm had developed their products and innovations in house much more than did small firms and only 1 out of 6 small firms had developed their products or innovations in-house which was significant statistically at the level of p-value of 0.1. In addition, the survey showed that small and medium-size firms had more cooperation with other local firms rather than large ones for the development or adoption of the their products suggesting that small firms may cooperate with large firms to develop or adopt their product given the fact that most of small and medium-sized firms interconnected with large firms and acted as sub-contractors for them. Also those were large and medium-sized firms which had purchased some technical knowledge from international or national sources which was significant at the level of p-value < .05%.

Table 6 The frequency and linkages of technical innovation and development

Types of Innovation	frequency	%	t-b	p=
Product or process innovation in-house	25	89	1.812	0.070
Ideas and information for innovation	26	93	1.570	0.115
Technological Innovation				
Developed in-house	14	50	1.812	0.070
Adopted in-house	24	86	0.563	0.573
Cooperation with other local firms	12	43	-0.588	0.557
Cooperation with local universities	10	36	0.578	0.563
Licensing	7	25	1.051	0.293
The purchase of technical knowledge	5	18	2.003	0.045
Other	5	18		
Product Design				
Developed or adopted in-house°	23	83	1.187	0.235
Developed by other institutes°°	4	14	1.020	0.398
By reverse engineering°°°	21	75	0.729	0.466
Local universities °°°°	4	14	-0.279	0.780
Made by customer design°°°°°	21	75	-1.635	0.103

Source: Calculated by authors

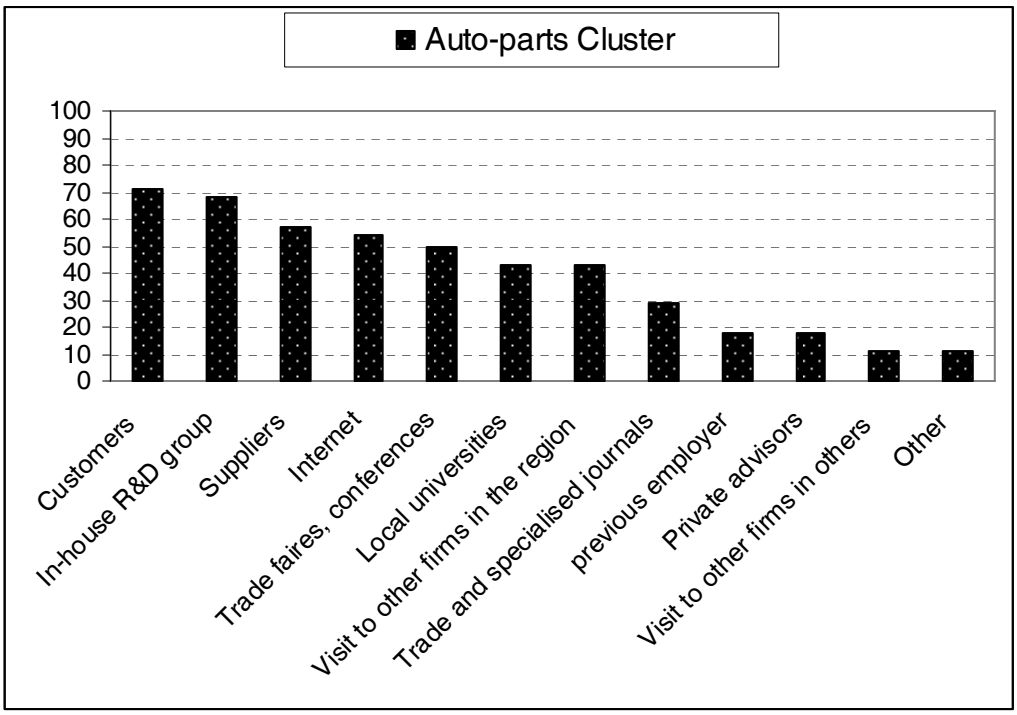
Note: Multiple response were possible

*Cross-tabs/Kendal's-tua-b:

Nearly all of firms in the cluster were looking to implementing quality standards systems and most of them had acquired the highest quality standards like QS and ISO: TS and mostly high ranking of the leading companies in the region, signing of interconnection of the local firms with the metropolitan and global institutes in the field of quality standards.

The main source of innovation in auto-parts cluster was acquired from customers, in terms of 71% of the responding firms, which means customers played a key role in stimulating the innovation process and increasing the learning capacity of suppliers. And also, for about 69% of firms, in-house R&D units within firms played an important role possibly for reverse engineering and some adaptation in product improvement and then suppliers (67%) were determining factors for the innovation process of firms. Also, both national and foreign trade fairs were important places to imitate new products, getting a better idea for innovation 50% of responding firms. The internet as a new

phenomenon was a part of innovation source for about 53% of the firms (Figure 1).



Source: Calculated by Authors

Note1: Multiple response were possible

Note2: Cross-tabs/Kendal's tua-b: (for customers, t-b: 1.490, p=0.136); (in-house R&D groups, t-b:1.167, p=0.243); (suppliers, t-b:1.815, p=0.070); (Internet, t-b:-0.936, p=0.349); (Trade fairs, t-b:0.710, p=0.476); (local universities t-b:-0.715, p=0.474); (inter-firm interaction, t-b:-0.025, p=0.980); (trade and specialised journals, t-b: 0.736, p=0.462); (previous employees, t-b:2.236, p<0.05) (visit to other firms in other regions, t-b:1.1292, p=0.196); (private advisors, t-b:0.757, p=0.449)

Figure 3 Metropolitan knowledge sources in Auto-parts cluster

Visit to other firms in the region reflects a sign of inter-firm cooperation in the region, demonstrating exchange of knowledge among firms. Moreover, visit to other firms in other regions was less effective for the firms as a source of innovation which means that spatial proximity and region milieu were vital for the enhancement of learning capacity and innovation. It is interesting that some of firms (18%) had private advisors who assisted them in achieving technical innovations. Statistical test show some important differences in the sources of learning. Suppliers tended to be an important source of learning for large firms more than small and medium size with significant difference statistically at the level of

p-value of <0.1%. Trade fairs and conferences, trade and specialised journals, visits to other firms in the region, the internet were sources of learning and innovation for all sizes of firms but without statistically significant differences between them. Previous employees were statistically significant for large firms rather than small and medium-sized firms at the level of <.05 %.

5.5. Inter-firm Competition and Cooperation

It has been widely acknowledged that the inter-firm competition is an inevitably phenomenon of industrial clustering. From Porter's view, local competition is one of the strongest spurs to individual company growth and the combination of both competition and cooperation among local firms is one of the key drivers of regional economic development (Porter, 2000). Table 7 suggests the number of competitors in the auto-parts cluster, hence 7% of firms stated that they had no competitors in the region. 46% of the interviewed firms had one or two

Table 7: number and geographical location of competing firms in Auto-parts cluster

	Number of firms	%	*t-b	p=
Number of competitors				
None	2	7.2		
One or two	13	46.4		
Three or more	13	46.4		
Total	28	100	0.534	0.593
geographical location				
Tehran metropolitan region	21	75.0	-1.051	0.293
120km Radius or adjacent provinces	6	21.4	1.186	0.236
Rest of Iran	11	39.3	0.542	0.588
Abroad	8	29	1.786	0.074
Total	28			

Source: Calculated by authors,

Note: Multiple response were possible

*Cross-tabs/Kendall's tau-b

competitors. Also 46% of firms had three or more competitors without significant difference statistically among different size of firms. Since, considerable numbers of auto-parts manufacturing firms are concentrated in the Tehran metropolitan region, the main

competition for the firms occur About 75% of firms reported that their main competitors are situated in close proximity. 21% of the firms stated that their competitors were within a 120km radius of Tehran or neighbouring provinces. While 39% of the responding firms placed their competitors in the rest of Iran, mainly in Mashad, Tabriz and Esfahan which are the major centres of auto-parts in Iran after Tehran. Only 29% of firms also claimed that their competitors were abroad (Table 7).

Moreover, there was a certain degree of horizontal inter-firm cooperation in the automotive parts cluster. In terms of intensity of relationships, about 20% of firms reported very fluent ties with other local firms and 30% had fluent relationships and also for 20% the relationships with other firms were occasional. In addition, 12% of firms stated that they had little relationships with other local firms while 18% of firms never had relationships with other local firms. One of the interviewees states *'we cooperate with similar firms despite the fact that we understand that they are our competitors. We give them some advisory services and help them for providing and supplying of the raw materials and give them some their needed components.* The firms were also asked if they had any formal agreements with other firms. The findings show that 50% of the responding firms confirmed that they had formal agreements with other firms; these kinds of formal agreements were increasing with local firms for supply of parts. It was interesting that about 36% of firms had some sharing with other local firms while some firms (21%) stated that other firms have some sharing in their own firms, which means that the trend is towards embedded networks of firms into the region. Large firms had much more of a tendency to purchase other local firms and they were also interested in selling a part of their own collaboration with other firms than was the case for small and medium-sized firms. In addition, 25% of the firms declared that they frequently exchanged ideas and information or discussed their problems with other producers and 57% had occasional ideas and information exchanged (see table 8). An interviewee indicated that '*We have good relationships with some firms in the region and we usually have regular meeting with them and discuss about different subjects and we try to find solutions for some of our problems in these meeting. These meetings are held in each other firms'*. It is interesting that large and medium-sized firms exchanged their ideas and information together much more than did small firms (statistically significant difference at the level of p-value of <.05%). It is expected that the exchange of information or ideas appear to be important among firms given the fact that about 93% of responding firms believed that easy contact with other firms is a valuable asset for their

own. Moreover, as much as 85% of firms were appeared to be involved in informal relations with other firms and only 15% of firms stated that they have no informal ties with others.

Table 8. The intensity of exchange of Ideas and information in Auto-parts cluster

Intensity of exchange	<49		50-249		>249		total	
	no	%	no	%	no	%	no	%
Frequently	0	0	3	27	4	36	7	25
Occasionally	3	50	7	64	6	55	16	57
Never	3	50	1	9	1	9	5	18
%average	6	100	11	100	12	100	28	100

Source: Calculated by authors

Note: Crosstabs/Kendal's tau-b:2.190, $p<0.05$)

Considering this, the responding firms were further asked how their informal relationships occurred. About 82% of firms cited that industrial association was the best place for informal relationships with other firms. 63% of firms declared the informal relationship in social occasions such as trade fairs, phone contacts, training workshops and seminars held by customers and first-tier suppliers and so on. Geographical proximity was also important in terms of 52% of the interviewed firms while family relation was less significant in the auto-parts cluster and only 11% of firms cited family ties as the main stimulation of the informal relationships. However, these informal relationships have not yet transmitted to conscious joint cooperation in the region and only some firms had either bilateral or multi-lateral horizontal cooperation in the auto-parts cluster. Hence, the interviewed firms were asked whether or not they had any joint cooperation with other firms in the industry. Joint purchasing and joint ventures were widespread in auto-parts cluster. About 8 out of 27 of the interviewed firms (30% of firms) were cooperating with other component suppliers for joint purchasing and 7 out of 27 firms had joint ventures with other local firms. Some cooperation also took place in the training of workers (19%), joint use of machinery (22%), joint production (22%), joint exports (22%). In other fields such as joint testing (2 out of 27 firms) and common R&D networks (3 out of 27 firms) and also joint marketing (2 out of 27) there was weak cooperation among firms in the auto-parts cluster. Although, about 92% of the interviewed firms believed that joint cooperation with other firms can be effective in creating competitive advantage and reduction of transaction costs for firms in the cluster.

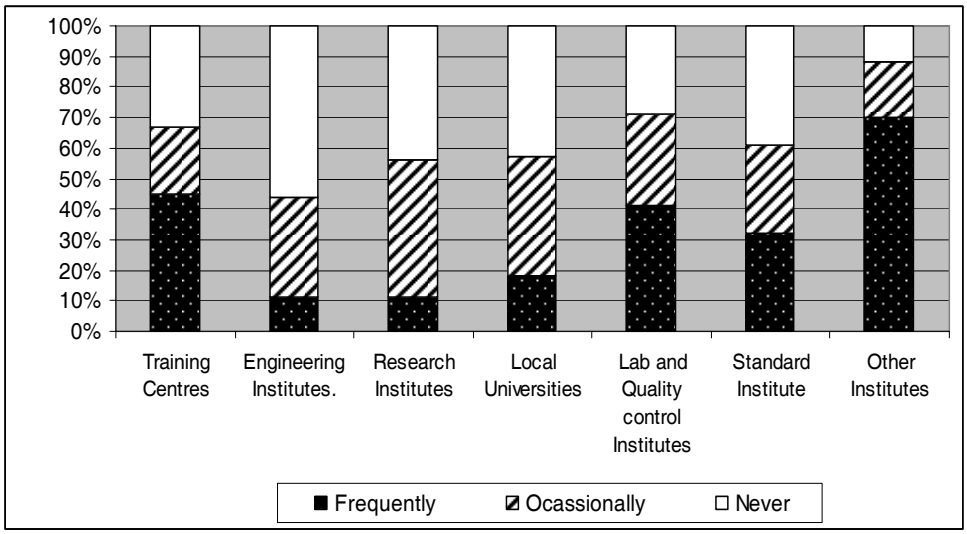
Table-1. Summary characteristics of the auto-parts cluster in the Tehran metropolitan region

Cluster characteristics	Auto-parts cluster
*Firm size and ownership	• many small and medium-sized firms with a handful of large firms, locally owned firms;
*Metropolitan labour market and employees of	• High inter-firm mobility, the new firm formation by spin-off from the existing Firms; informal and sub-contracting ties with parent firms, high availability of skilled labour force and strong relationship with metropolitan training centres.
*Backward and forward linkages	• Strong forward and backward linkages of small and medium-sized firms with suppliers of raw materials, components and specialised services institutes, • The formation of strong first, second and third-tier suppliers in the region
* Learning and innovation foundations	• Strong learning interaction and innovation between large firms and local suppliers, • flow of information and innovation through transfer of skilled labour force; informal or formal inter-firm cooperation; reverse engineering and imitation, fairs and exhibition, internet.
*Inter firm competition and cooperation	• Fairly strong concentration and competition in the metropolitan region; • Certain degree of horizontal inter-firm cooperation but mainly informal ties; relatively low joint action • Frequent or occasional fairly strong exchange of ideas and information
*Institutional environment	• strong linkages between firms and training centres, laboratories and quality control institutes; relatively low linkages between firms and local universities, engineering and research institutes; relatively strong linkages between large firms and local financial institutes, • Insufficient support of the government

Source: Calculated by authors

5.6. Institutional environment

The presence of different institutions such as universities, research institutes, laboratories and quality control institutes and so on and their strong linkages with relevant firms can also play a significant role in enhancing of industrial clustering. The survey suggests that the very large proportion of auto-parts firms (more than 67%) had either frequent (45%) or occasional (22%) contacts with training institutes in the region and that they had created strong linkages with these institutions. Laboratories and quality control institutes, which were in close proximity of these firms were regarded to be significant for 71% of the responding firms which had either frequent or occasional contacts with them. Some large firms interviewed, had their own laboratories and quality control units which were made available to similar firms or other institutes in the region which is indicating of other signs of multiple cooperation in the auto-parts cluster. Approximately 39% of firms had contact with the prestigious major universities.



Source: Calculated by authors

Note: Crosstabs/Kendal's tau-b (t-b: 2.070, p=0.038 for training centres); (t-b: 1.190, p=0.234); (t-b:3.611, p=0.000); (t-b:1.410, p=0.158 for local universities); (t-b:3.396, p=0.001 for laboratories and quality control institutes); (t-b:2.030, p=0.042 for standard institute)

Figure.2: Linkages of auto-parts cluster with other metropolitan institutes

Moreover, the Standard Institute which is affiliated to the government and which monitors product quality and sets product standards were regarded to be significant for about 32% of firms as 29% of firms had some contacts with this institute (Figure 3). There was significant

difference between size of firms and contact with other metropolitan institutions such as training centres, research institutes, laboratories and quality control institutes, standard institute at the level of p-value of <0.05%, which means that medium and large firms had some stronger degrees of linkages with other metropolitan institutions in comparison with small firms. The survey suggests that the role of government for the support of auto-parts cluster is insufficient. 50% of the responding firms believed that the state rules for their business environment is weak and very weak. 39% assessed it as only average. One of the interviewee's believed that '*the government decisions are always changing, which has led to instability in the decision-making for firms. For example, we are going to invest in research and development of the firms but we have some concern that after a while the government could make a decision to leave the market for our foreign competitors and then we would lose all our investment while we need to make ready ourselves against both national and global rivals….. we are worry because we can not draw up a specific perspective for our own future'*. Moreover, many of the firms reported some degree of linkages with financial institutions especially with the national and local banks in the region. 96% of firms obtained at least 32% of their financial sources by bank loans, 93% also believed that their own capital was important for their survival in the market where more than 58% of their financial sources was supplied through their own savings which may be a constraint factor in the expansion of business and innovative activities within the cluster. Moreover, 23% of firms supplied about 6% of their financial sources from the cash advances of customers. Other financial institutions such as financial intermediaries, investment funds and other credit and financial institutes did not play a key role in providing the capital of firms and this shows that available resources for firms was only limited to financial resources of firms themselves, some bank loans and cash advance payments of the customers. The survey suggests that medium and large firms had a greater dependency to bank loans and cash advances than did small firm while small firms met these needs from their own financial sources and financial intermediaries.

6. Conclusion

The objective of this research was to provide some insights of the nature of the phenomenon of industrial clustering and search for the driving forces that enhance the learning processes and innovation capacities contributing to competitive advantage in the auto-parts cluster. From the 1960s until the early 1980s, there were insufficient local networks in the Iranian auto-parts cluster. However, the survey suggests the accelerating

growth in this sector since the late 1980s and early 1990s which has been the driving force of the economy of Tehran metropolitan region. The first implication of this growth was the formation and the birth of the extensive networks of small and medium-sized firms in close proximity with a few leading automotive companies. Thus, the presence of two leading firms and some other commercial and passenger vehicles manufacturing companies played a critical role in the spatial clustering and have acted as a catalyst in the formation of the auto-parts cluster. The large and available pool of skilled and well-experienced labour force, high inter-firms labour mobility, extensive spin-offs and the formation of new firms start-ups by the former employees of the existing firms are helping to increase the dynamism of the cluster in the region. Moreover, local linkages in auto parts and components have deeply embedded the auto-parts cluster into the Tehran's economy where it would be regarded as significant to regional economic development and its self-sustaining growth (Turok, 1993). The reason is that the customers and also suppliers are the two main sources of information in which learning and innovation processes take place to the auto-parts firms despite the fact that only a minority of firms had horizontal cooperation with the other firms. Moreover, the level of informal cooperation is very common among firms located in the auto-parts cluster and industrial associations and social occasions play a catalyst role for the formation of these relations. These kinds of cooperation have significantly contributed to the formation of local networks in what Park and Markusen (1995) have called the hub-and-spoke type clusters. Similar results obtained by Kim (2005) in his studies from U.S, auto-parts suppliers. That clusters observed in the automotive industry indeed differ from the agglomeration patterns identified by Alfred Marshall, in that they take the form of hub-and-spoke nexus consisting of complexes of suppliers surrounding hub or anchor assembly facility, where the hub firm plays a key role in organising the entire production system. In contrast to what might have been expected from existing literature on industrial clustering and regional development, the empirical findings show that the institutional environment and the presence of substantial institutions have not encouraged the learning and innovation capacities of the sample industrial clusters, even though there is some strong evidence of linkages between the clusters and some of the metropolitan institutions such as training institutes, laboratories and quality control institutes and standard institutes which are in close proximity of these firms. Therefore, although there is "strong institutional presence" in the region, they have not embedded in the other actors that constitute "institutional thickness", and it is "institutional thinness" that is the main weakness of the region. This means that there is little interaction amongst the institutional networks that, in time, forms a "social

atmosphere" of shared rules, conventions and so forth. Such "thickness" further benefits the clusters in terms of further learning and innovation in the region. Moreover, the major findings show that small and medium-sized firms in the auto-parts have stronger linkages in the Tehran metropolitan region economy than do the larger firms. For example, in the auto-parts while small and medium-sized firms sourced a considerable proportion of their raw materials, components and new machinery and equipment from metropolitan suppliers, large firms were more reliant on national and global linkages. This strongly supports the hypothesis that smaller firms have a higher proportion of intra-metropolitan linkages and are more regionally embedded (Almeida and Kogut 1997; Eraydin and Armatli-Köroğlu 2005). It reflects strong signs of industrial clustering and the transfer of learning and innovation from the larger firms to the smaller firms in the region. A total conclusion can be drawn from the success of the auto-parts cluster in developing and supplying the majority of parts and components needed locally. This is of the key message of the industrial clustering phenomenon that has occurred in the cluster, and could provide a guideline for other industries and policymakers for facilitating endogenous regional development. This research was only a first step towards a better understanding of the factors that underpin industrial clustering and regional economic development by providing some empirical evidence in the Tehran metropolitan region and further research still needs to be done to provide a fuller picture of the nature of industrial clustering in Iran.

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خوشه های صنعتی، نوآوری و مزیت رقابتی در مناطق کلان شهری: شواهدی از خوشه صنعتی قطعات خودرو در منطقه کلان شهری تهران

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این مقاله در جستجوی یافتن شواهد تجربی از ماهیت پیوندهای درون منطقه کلان شهری تهران و خوشه ای شدن صنعتی و تاثیر این پیوندها بر فرایند یادگیری و ظرفیتهای نوآوری صنعتی در بخش صنعتی قطعات خودروست که ماحصل آن ایجاد مزیتهای رقابتی در منطقه می باشد. تحقیق نشان می دهد که رشد شتابان بخش خودرو از دهه گذشته محرک اصلی اقتصاد منطقه کلان شهری تهران در محیط اقتصادی جهانی شده بوده است وبخشی ازاین رشد مدیون ایجاد پیوندهای سیستماتیک و خوشه ای شدن صنعتی بوده است. همچنانکه تحلیل مطالعه موردی شمار قابل توجهی از یافته ها را درباره درجه قوی ازخوشه ای شدن صنعتی را در منطقه کلان شهری تهران نشان می دهد اگرچه شواهدی از محیط نهادی ضعیف را می توان در منطقه پیدا کرد.

واژگان کلیدی: خوشه ای شدن صنعتی، یادگیری، نوآوری، مزیت های رقابتی، منطقه کلان شهری تهران

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