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## **Barriers and Limitations in the Development of Industrial Innovation in the Region**

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### **ABSTRACT**

The growing interest in public policy contributing to the expansion of industrial innovation have become increasingly significant, resulted from the interrelationship between innovation, competitiveness, and economic growth. Thus the identification of barriers and limitations factors hindering the success of innovation will define the principles basis on which efficient and success public policy has to be based.

This paper presents the results of an empirical study in identifying the most important barriers to the development of innovation, as ascribed by industrial firms belonging to the hi-tech sector alongside with more traditional industries. The data collected through field survey of industrial firms located in the Northern region of Israel and cover two different sub-regions: metropolitan core, and periphery. The study investigates also the differences between the industrial sectors and type of regions in the importance that ascribed to the various barriers.

Considerably similarity was identified in the most important factors that constitute barriers that slowing down or all together stopping innovative projects, between the industrial sectors and the different regions investigated. These findings could facilitate in design a comprehensive policy in order to minimize the negative impact of such barriers.

## **1. Introduction**

The contribution of innovation to regional growth has been widely identified and documented in the literature (Davelaar, 1991; Feldman, 1994; Feldman and Kutay, 1997; Davelaar and Nijkamp, 1997; Frenkel and Shefer, 1997). This result from the relation between innovation, competitiveness, and economic growth (Schmookler 1966; Rosenberg, 1972, 1976, 1994; Nelson and Winter, 1982; Freeman, 1974; Freeman et al., 1982; Romer, 1990, 1994; Bertuglia et al., 1995; Bertuglia et al., 1997; Nijkamp and Poot, 1997).

Advanced economic activities tend to possess a high market value, resulting in a competitive advantage at least during the first stage of the diffusion process. Thus, these activities provide new and at times unique opportunities for the development of firms, the expansion of their market shares, profitability and employment growth. Therefore regions characterized by a high level of technological innovation will show a greater acceleration of economic growth (Grossman and Helpman 1990a, 1990b, 1991, 1994; Krugman, 1979, 1991, 1995; Stokey, 1995).

Entrepreneurs who seek to maximize their profits, are motivated to invest in regions where the greatest profits can be achieved, given some pre-specified level of probability of the risk involved owing to uncertainties (Shefer and Frenkel, 1998).

Due to the great contribution of the innovative activities to the economy of the region, it is of great interest to identify the barriers and obstacles that limit the development of innovative activities in the region. Thereby address an efficient policy in order to minimize such limitations. Evidences indicate the differential characters of industrial firms that belong to different sectors (Frenkel, 2000; Frenkel and Shefer, 1997). These differences appear in the firm's attributes and the character of the production milieu where they are located that could supply a supportive infrastructure and encouraging the development of innovation. Thus, it is appropriate to inquire the differences between the firms in the important they ascribe to the various factors that hinder and limit the development of innovation, in regard to their geographical location and branch affiliation. An effective policy will then have a positive influence on the spatial diffusion of innovation by raising the attractiveness of the region to innovative firms.

The objective of this study is to identify the significant factors that address barriers and limitations in front of spatial innovations, based on database gathered through field survey of

industrial firms. Given the great importance attributed to the limitation variables on the ability of a firm to create new technologies, particularly as regards the level of innovation, the study analyzes those variables related to the location differential. The study also examines whether the structure of industrial branches affects the presence or absence of barriers and limitations on the creation of innovation by the firms.

The remainder of the paper is organized as follows. Section 2 provides the context for the study including a brief overview of the role of innovation in the economic growth of the region. Section 3 describes the methodology of the study. Section 4 then extends the analysis to investigate the impact of various limitations factors on the ability of the firm to be engaged in innovation. Section 5 concludes with a review of the implications for public policy.

## **2. The Role of Innovation in the Economic Growth of the Region**

### **Technological Progress and the Innovation Process**

The most powerful paradigm for technological progress remains Schumpeter's model of evolutionary process (Schumpeter, 1950), and the interpretations and extensions of the model (Nelson and Winter, 1982). According to this model, ideas, innovations and technologies compete for resources in an environment characterized by economic scarcity. Ultimately, the technology most suited to the times and the condition triumphs, though the process may be long, time-consuming and somewhat inefficient. The Schumpeterian evolutionary models imply that as technology ages more and more firms gain the opportunity to learn and use it, as they observe other firms and adapt it.

Innovation is concerned with "the search for and the discovery, experimentation, development, imitation, and adoption of new products, new production processes and new organizational set-ups" (Dosi, 1988, p. 222). It enables producers of products and services to operate more efficiently and thus increases the competitive edge of the economic unit. It also improves their ability to trade and market their product(s) or services on the local, national or international markets. It is therefore sufficiently clear that technological change and innovation processes can serve as the principal vehicle for advancing and promoting the growth and development of regions.

### **Diffusion of Innovations**

The role of information and knowledge in the process of technological change and the diffusion of innovation cannot be over emphasized. Advanced means of communication serve

as a vehicle for disseminating knowledge over space. The element of space can be appreciably overcome with adequate means of communication. Therefore, advanced means of communication are a necessary component in the process of regional development and economic growth (Shefer, 1988, Felsenstein, 1996, Frenkel, 2001).

The precise nature of the process by which innovation procedures diffuse through an economy, from region to region, and from one economy to another, and through which one firm learns from another, is very important, because it is a crucial determinant of competitive advantage.

Technology diffusion is a complex process, involving changes in the behavior of economic agents. Many studies emphasize the great importance of the technology diffusion process for market development, but despite this, it is surprising to find that only a few policies are designed to foster this process. The societal expected return on new technology without the diffusion process will be insignificant (Metcalf 1990).

Regional economic competitiveness is directly and strongly dependent on the spatial diffusion of innovation processes. Evidently innovations, creations and/or adaptations are marked by pronounced regional spatial variations.

### **The Innovative milieu**

The spatial competition has become a function of the new dynamic of urbanization, with more intensive and universal character than ever. Cities and region are competing each other in attracting new investment and preserving their existing economic activities. Porter (1990) and later Nijkamp and Veleugel (1993) defined five attributes that specify, in analogical terms, the business milieu of the region. Those are: 1) *hardware* – including the basic location factors: labor, the availability of land, infrastructure and capital. 2) *software* – expressed by the urban quality of life where residential and employment milieu are determine factors in the locational choice process. 3) *orgware* – regards to the management form of the other attributes. 4) *finware* – including the business and finance regulation, and 5) *ecoware* – define the environmental aspects. Together they determine the sustainable development of the region.

The local innovative milieu is perceived as enhancing the innovative capability of firms. It is considered a cost-reducing agent/factor that diminishes uncertainty and increases production efficiencies (Camagni, 1991; Kleinknecht and Poot, 1992). The principle force that foster the economic growth of the region results from the significant role that agglomeration economies

have on production efficiency (Richardson, 1974, Segal, 1976; Henderson, 1986, 1988; Giersch 1995, Harrison et al., 1996; Matello, 1997).

The concentration of firms in the region and their connection with research institutions create a source of knowledge and specialization which enhancing the development of new technology and through it effect the innovative capability of the firm. The local synergies expressed by the socio-economic interactions among firms in the region and their relation with research institutes are crucial to the economic growth of the region and shape the innovative milieu (Camagni, 1995). These synergies facilitate the dissemination of the knowledge and information which enable the creation of technological innovation. This component increases the innovativeness in a region through processes of imitation, interactions among local agencies, cooperation between the private and public sectors in setting up infrastructure and services, interactions between research centers and the firms which engage in development and adopt inventions and innovations as well as cooperation between suppliers and consumers. The creation of these synergies is likely to compensate the local economy for its inability to create economies of scale, especially in small and lagging regions. Cooperation with external agencies is also important in places where the processes of development result from local initiatives, for over time it is not possible to rely only on local ability, given the competitive limitation of small areas. The contact of industrial plants with external research centers and institutions is essential for the development of competitive and innovative skills especially in the peripheral regions (Camangi,1995).

### **3. Methodology**

#### **3.1 Objectives and Hypotheses**

This study intends to identify the differences between firms in the importance they attach to factors that facilitate against those that limit the development of innovation, as a function of their geographical location and the industrial branch to which the firm belongs. The findings will help to determine public policy aimed to reduce barriers and risk factors and encourage the development of facilitative and supportive milieu. Certainly, such a policy will support the establishment of innovative industry which is likely to exercise a positive affect on the development and growth of the region.

In general, public policies are more universal than specific oriented in accordance to regions and branch affiliation. In many cases the government avoid from giving particular treatment that is hard to identify, and limited themselves to general rules (Frenkel et al., 2000).

Therefore it is worth to find out whether the barriers and limitations to innovation are common phenomenon to various industrial sectors and regions, thus could handle with more general policy, or it is differ and there is a need to determine specific strategic to each industrial sector or in each sub-region.

One of the difficult mission of the technological initiator is the achievement of financial sources that are vital need for the survival of the firm and have a positive effect on the innovativeness of the firm. Studies confirm that availability of capital is crucial for the economic growth of the firms. The absence of financial sources stimulates the failure of the firm, by limiting the firms in its investment and growth (Brophy and Shulman, 1993; Erramili and D'souza, 1993). The investment engaged in the initial stages of the development includes double risks. First the long period of investment in R&D needed to complete the development. Secondly, the competition and the dynamic that exist in the market, especially in the hi-tech sector, increase the risk due to lack of technological adjustment of the new products under developed.

Accordingly the hypothesis to be test is that the lack of financial sources and the risk factors are the most significant barriers to the development of innovation. Their existence has negative significant effect in any location.

However, we hypothesized that there exist other differences between the metropolitan areas and the peripheral regions in regard to the various barriers hindering innovation their, due to the different characteristics of these two types of regions. We also hypothesized that the barriers to innovation vary also according to industrial affiliation, based on the nature of the industrial sector. While the Hi-tech industry characterized by a multi-disciplinary efforts required for developing an innovation, this kind of operation in the traditional industries, in many of the cases is 'one man hand maker'. Therefore it is expected that the level of impotence regards to the limitation factors will be higher within firms belonging to the hi-tech sector, than in the more traditional industrial sector.

Another test regards to the Israeli strategic choice to concentrate mainly in R&D intensive activities in the development of high technology industry (Roper and Frenkel, 2000). Accordingly, it is hypothesized that the absence of technology or R&D services are very limited and does not hindered the development of innovation, even in the remote regions where firms can rely of outsourcing R&D services. Conversely, is the lack of highly skilled

labor in the region that could effect negatively the ability to innovate, since it is difficult to commute skilled labor to large distance.

### **3.2 The Data**

The empirical study based on the analysis of database collected in a field survey that was carried out in the Northern region of Israel. The sample of industrial plants was randomly selected from three Fast Growing Industries (FGI) with high capacities for innovation. The sample comprised 211 randomly selected industrial firms represents about 72% of the total industrial plants in the FGI category mentioned above, located in the Northern region of Israel. A carefully designed instrument was used in a personal interview administered to senior managers from each of the firms in the sample. (for more details on the sample selected see also: Shefer, et al., 2001).

The selected industrial branches were divided into two categories: the first category, representing the hi-tech industries, includes electronics, electro-optics, optics, and precision instruments. The second category represents the more traditional industries and includes the plastics and metal products. The justification for this grouping came from the numerous variations that were found in the innovative properties characterizing these two industrial groups (for more details see Frenkel et al. 2001).

### **3.3 The Region**

The northern part of Israel were chosen for the study as it represents a classic pattern of an area encompassing the different types of sub-regions identified for the investigation. In 1998 some 1.5M people consisting about 26% of the population of Israel resided in this region. For the purposes of the study the northern region divided into two sub-regions: 1) The Haifa metropolitan area the main urban core in the North. This sub-region includes the core zone and its outskirts – the central Galilee located on the fringe of the core zone, and are within an acceptable commuting distance. 2) The peripheral areas, comprising the less developed areas of the Northern region. These areas are removed from the metropolitan influence, and are not within an acceptable commuting distance (see Map 1).

### **3.4 The Research Method**

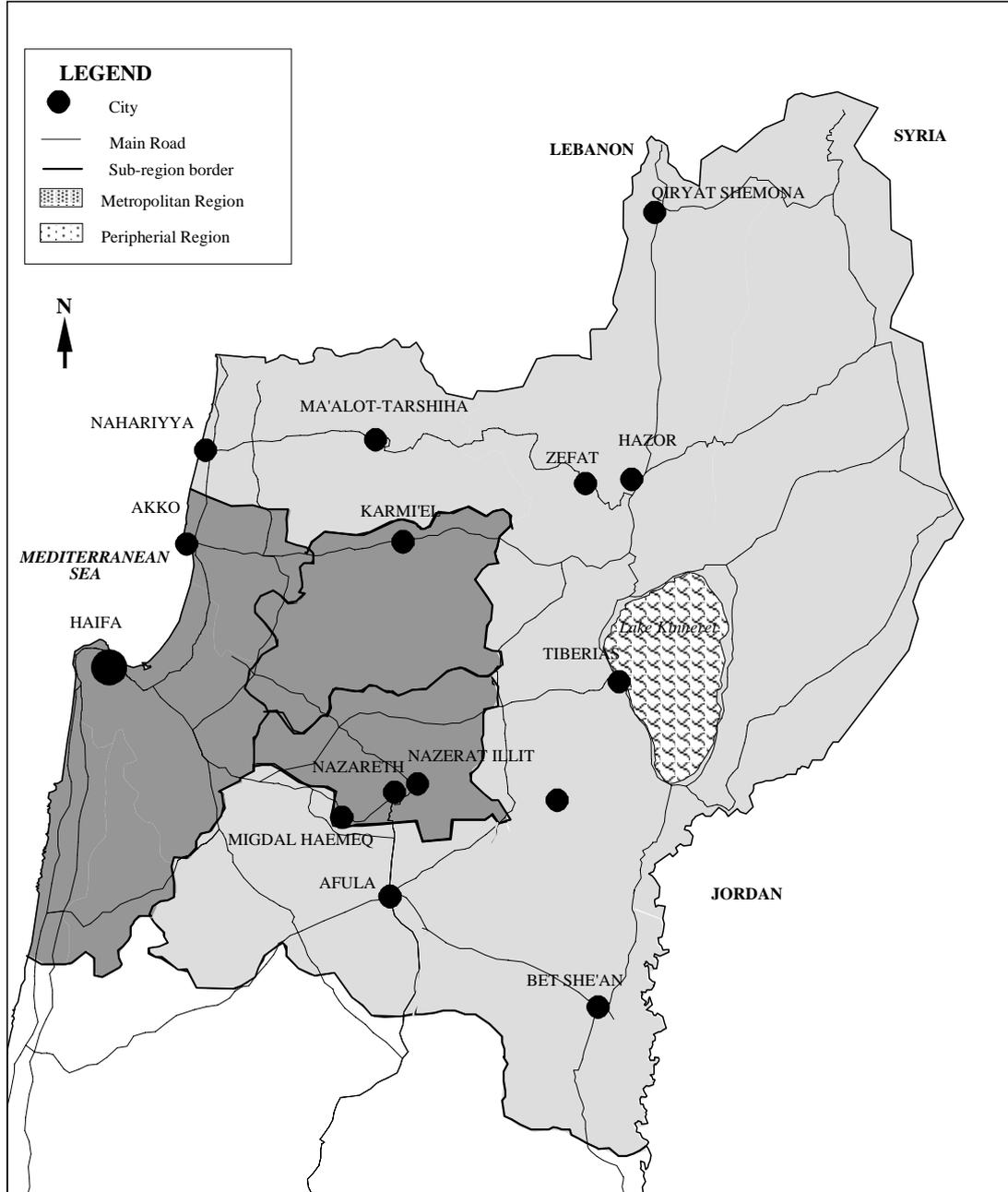
During the field survey firm directors were requested to state the importance they would allocate to various factors which constitute barriers to innovative success, by ether slowing down or altogether stopping an innovative project. Those interviewed were presented with a

list of 17 factors which were scored on the basis of a 1-5 scale indicate the relative importance that ascribe to them as hindered the realization of innovation in their firm: (1) no significant; (2) slightly significant; (3) moderately significant; (4) very significant; (5) crucial.

For each factor the sum awarded by those interviewed and the mean score were calculated. The higher a factor's score the greater its influence on the final score. In addition, a Mann-Whitney a-parametric test was conducted to examine the inter-regional differences in the importance allocated by the plants to each of the 17 factors. The study included two testing phases:

- a. In the first stage, the importance conferred by the firm to each of the barrier factors were examined by calculating the mean score, thus ranking the 17 factors according to the relative final score allocated to them by the firm's directors. In addition the inter-regional differences in the relative importance allocate to the 17 factor among the firms were examined.
- b. In the second stage inter-sectorial differences were tested by calculating the mean score of the 17 factors separately in each of the industrial sector included in the survey. It was also possible than to identify the inter-regional differences that exist in each of the industrial sector.

**Map 1: Major Area Division of the Israeli Northern Region**



## **4. Results**

### **4.1 The Principal Factors**

The result obtained from calculating the mean score of each of the 17 factor allocated by the firm's directors are presented in Table 1 below. The results of the inter-regional analysis using the Mann-Whitney a-parametric test are also presented in the Table.

It is clear evidence from the results that most of all the lack of capital resources and the high level of risk involved in the investment on innovation, reduces the capability of the firm to engage in innovation. This result is valid also when dividing the firms according to branch affiliation (see in details in the next section) or location. These kind of limitations could be handle more successfully by public policy than others, directed in offering capital subsidy or attract investments of venture capital to the region.

The five principle factors that show the highest mean score present those that ascribed by the entrepreneurs' order of priorities (presented in Table 1) as hindered mostly the realization of innovation in their firm. In accordance the most significant obstacles related to excessive perceived risk, lack of sufficient financial resources and prohibitive cost. The last barrier in this category related to the lack of skilled personal.

The next group of factors ascribed by medium level of significance includes supportive factors where their absence hindering the appearance of innovation. These are: the lack of technological knowledge and the lack of information on market opportunities. This group includes also uncertainty variable, for example those that involved with the lack of market demand for the new product or process, or the uncertainty that involved in the timing of innovation.

All the others eight factors from the presented list hardly influence the ability to innovate. The insignificant that ascribed to the lack of R&D services as hindering the ability of the firms to innovate was expected. The important role that R&D services play in contributing to the engagement of the firms in developing innovation documented in different studies (see for example: Frenkel 2000; Frenkel et al., 2000, 2001; Roper and Love, 1996; Dosi, 1988; Rosenberg, 1985; Nelson, 1986).

**Table 1: Barrier and limitation factors: ranking according to the mean scores of the level of importance**

Barrier and limitation factors to innovation	Rank	Mean Score	S.D	% of firms indicating the limitation factor as very significant or crucial			Mann-Whitney Test	
				Total firms	Firms in Metropolitan	Firms in Periphery	U	Z
excessive perceived risk	1	3.22	1.39	47.4	48.8	45.5	5404.0	-0.019
Lack of sufficient financial resources	2	3.18	1.53	50.7	56.9	42.1	4918.0	-1.159
Prohibitive costs	3	3.13	1.32	46.4	50.4	40.9	5034.0	-0.887
Long return on investment	4	2.97	1.33	38.4	41.5	34.1	4956.5	-1.066
lack of skilled personnel	5	2.92	1.37	39.1	36.1	43.2	4535.5	-1.960*
Lack of information on market opportunity	6	2.30	1.28	21.0	26.3	13.7	4677.0	-1.651**
Uncertainty in timing of innovation	7	2.19	1.28	18.8	21.5	14.9	5058.0	-0.439
Lack of technological knowledge	8	2.17	1.19	16.5	15.5	18.2	5069.5	-0.819
Lack of market consumption	9	2.15	1.40	21.4	25.4	15.9	4759.0	-1.512
Lack of opportunities for cooperation with other firms	10	1.95	1.15	12.0	15.7	6.8	5199.0	-0.310
Lack of R&D services	11	1.88	1.18	12.8	11.4	14.8	4498.0	-2.293*
Innovation control difficulties	12	1.81	1.04	8.6	8.2	9.1	5270.5	-0.246
Lack of technological opportunities	13	1.76	1.15	12.8	13.9	11.4	5043.5	-0.859
Legislation, norms, regulations, standards, taxation	14	1.73	1.19	11.4	14.0	8.0	4790.5	-1.574
Resistance to change in the enterprise	15	1.65	1.04	.9.1	5.7	13.6	4145.0	-3.288*
Deficiencies in the availability of external technical services	16	1.64	0.93	6.2	4.9	8.0	4318.0	-2.760*
No need to innovate due to earlier innovations	17	1.40	0.81	3.4	4.1	2.2	4773.5	-1.836**

Total number of observation 211. Number of observation in metropolitan area = 123, in periphery = 88.

\* Significant at the 5% level. \*\* Significant at the 10% level.

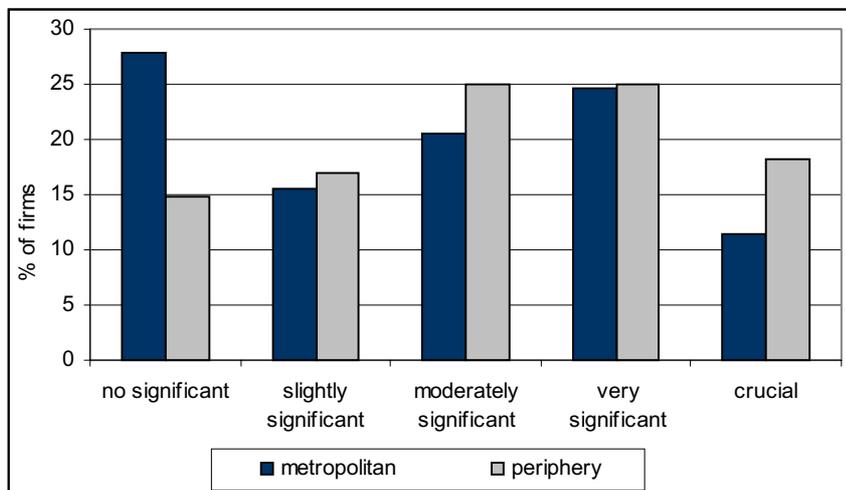


Strategically, Israel concentrate in its industrial development on R&D, especially in the hi-tech sector (Roper and Frenkel, 2001). This policy had lead to the development of R&D services in great extent, thereby reduced to the minimum this barrier.

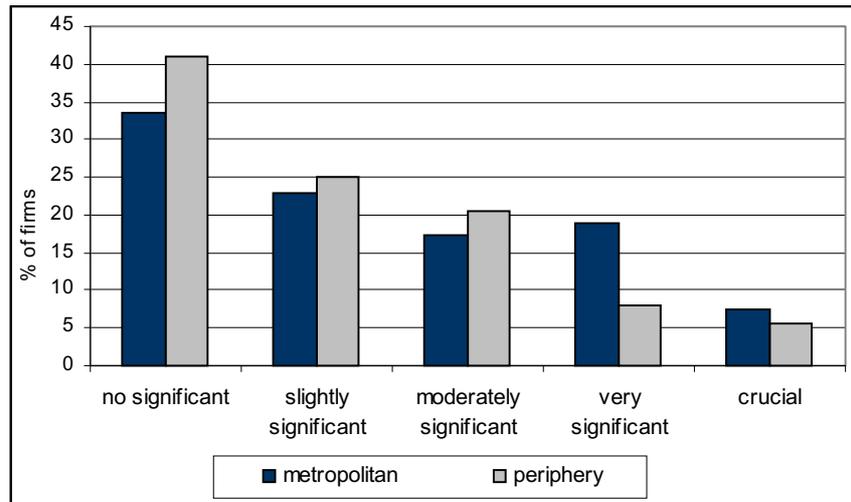
All the others eight factors from the presented list hardly influence the ability to innovate. The insignificant that ascribed to the lack of R&D services as hindering the ability of the firms to innovate was expected. The important role that R&D services play in contributing to the engagement of the firms in developing innovation documented in different studies (see for example: Frenkel 2000; Frenkel et al., 2000, 2001; Roper and Love, 1996; Dosi, 1988; Rosenberg, 1985; Nelson, 1986). Strategically, Israel concentrate in its industrial development on R&D, especially in the hi-tech sector (Roper and Frenkel, 2001). This policy had lead to the development of R&D services in great extent, thereby reduced to the minimum this barrier.

In order to find the differences between the metropolitan region and the periphery in accordance with the limitation factors, a Mann-Whitney a-parametric model was conducted. The results obtained from the model (see Table 1) identified 7 factors in the list in which the differences ascribed to them by the firms' directors were statistically significant. However, just only one factor belong to the first priority group and another to the medium level priority group. These are the lack of skilled personal and the lack of information on market opportunities. Figures 1 and 2 present the distribution of firms according to the level of importance they ascribed to these two barriers, in comparison between metropolitan area and the peripheral zone.

*Figure 1: Distribution of firms (%) according to the importance they ascribed to the lack of skilled personal as a barrier to innovation, by regions*



*Figure 1: Distribution of firms (%) according to the importance they ascribed to the lack of information on market opportunities as a barrier to innovation, by regions*



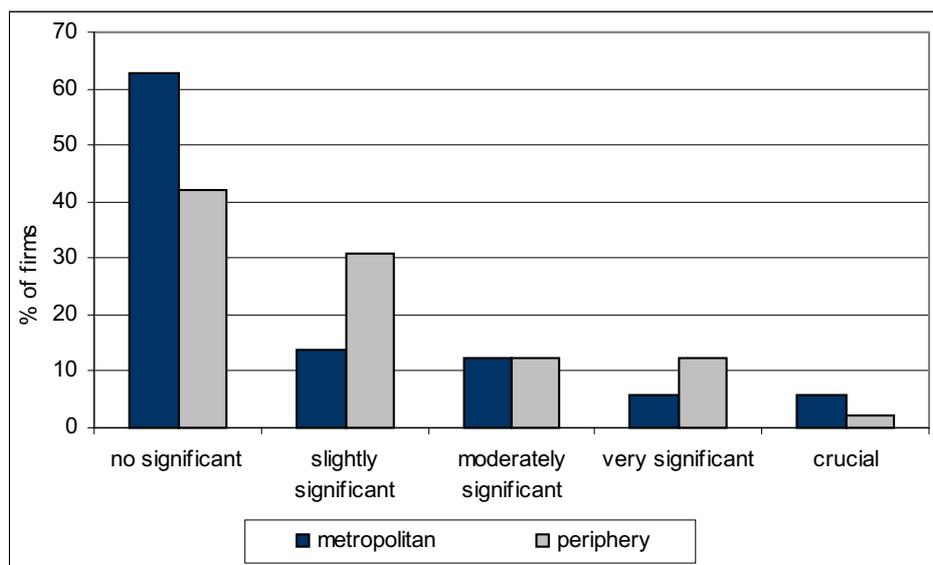
As one can expect, the importance ascribed to the lack of skilled personnel, as limited the engagement in innovation, is much higher in the periphery than in the metropolitan area (see Figure 1). This result stems from the large pull of highly skilled labor that exists in the metropolitan area, in contrast to the peripheral region. The obtained results show an extreme distribution of the firms according to their location, expressed in a relative large gap in the edges. A high rate of the firms located in the metropolitan zone - 27.9%, indicated that this factor has no significant effect so far on the ability to innovate, whereas only 14.8% of the firms located in the peripheral region did. Conversely, a higher rate of the firms located in the periphery indicates this factor as crucial in constituting barriers to innovative success, in comparison to the rate of firms in the metropolitan area (18.2% and 11.5% respectively).

The opposite trend obtained in Figure 2 related to the lack of information on market opportunities. Here the advantage is to the peripheral region where less of the firms indicate this barrier as significant. The results show a high gradient in the distribution of the firms located in the periphery, where two-thirds of them ascribed no significant or just slightly significant impact of this barrier on the success of innovation, and only 13.6% indicated it as very significant or crucial. On the other hand, the distribution of the firms located in the metropolitan area is more balanced. Here more than a quarter of the firms indicated the lack of information on market opportunity as very significant or crucial to the ability to innovate. However, a high rate of the firms (56.6%) ascribed only slightly significant impact or non-at all on innovation. Why does the metropolitan area enjoy less accessible information on market opportunities than the peripheral region does? It is hypothesized that this effect is due to the different industrial structure characterized by the two regions. There are much more firms belonging

to the traditional industries that locate in the peripheral region, while the high-tech sector concentrate in the metropolitan area. The traditional industries rely mainly on the local market, therefore enjoy from high accessibility to information on this market opportunities. The hi-tech firms are more outsourcing oriented that naturally limits the accesses to sources of information on market opportunities. Looking on the distribution of firms according to the percent of export from turnover, confirm this hypothesis where the average percent of export within the hi-tech firms are 51.4%, while in the more traditional firms it does not exceed 25%.

As mentioned above, the result indicated the high existence of R&D services presented in the low rank given by the firms to the lack of R&D services effect on innovation. Yet it was found to be higher in the peripheral region than in the metropolitan area and statistically significant. The result depicts in Figure 3.

*Figure 3: Distribution of firms (%) according to the importance they ascribed to the lack of R&D services as a barrier to innovation, by regions*



The gap rely mainly in the percent of firms that ascribed no significant at all to the lack of R&D services as stimulate the success of innovation. More than 60% of the firms in the metropolitan area indicated so, but only 40% of the firms in the periphery. This result pointed to one of the main disadvantages of the peripheral regions jointly to the principal one -- the lack of highly skilled labors, but rather with much less effect. However, while public policy probably could successfully deal with the lack of R&D services, given financial incentives to the firms, it is much harder to handle with the lack of skilled labor in lagging regions.

#### **4.2 The inter- sectoral analysis**

In the second phase an examination of the barriers to innovation took place separately in each of the two industrial sectors. In addition, differences in each sector between the metropolitan area and the peripheral region were also examined. Table 2 presents the results in the hi-tech sector and Table 3 in the traditional sector.

Perhaps the most interesting and unacceptable outcome resultant from the order of importance ascribed to the list of barriers is the high correlation between the two extremely different industrial sectors. Both the hi-tech sector and the traditional industry ranked the same five economic barriers as the most effective factors on innovation, albeit with a slight changes in the inside order of these factors. The same was found with the next four supportive factors included in the medium level of significant group.

Such results pointed to the necessity to address more general policy in order to reduce the principal limitations, instead of adapting specific policy to each of the industrial sectors. Accordingly, such policy must emphasize mainly on the five economic factors that basically decrease the willingness and ability of the firms to engage in innovation.

A consistent higher mean score was found as ascribed by the hi-tech firms to the more important barriers (factors 1-9 in the list) than by the traditional sector. The explanation to this relies on twofold. First, the great experience that the hi-tech firms grant from their vast engagement in innovation, in comparison to that of the traditional industry. Such experience creates much more knowledge on the real effect of these barriers. This can be illustrated by the percent of firms (in the sample) that engaged in product innovation that comes to 72% in the hi-tech sector, and only 41% among firms belong to the traditional industry. Secondly, the development of new product in the hi-tech sector involved, in general, more complicated inputs in contrast with those that needed in the traditional industry. Thus increasing the effect of the risk

**Table 2: Barrier and limitation factors: ranking according to the mean scores of the level of importance in the Hi-tech Industry**

Barrier and limitation factors to innovation	Rank	Mean Score	S.D	% of firms indicating the limitation factor as very significant or crucial			Mann-Whitney Test	
				Total firms	Firms in Metropolitan	Firms in Periphery	U	Z
Excessive perceived risk	1	3.51	1.22	57.0	60.7	48.0	687.0	-0.745
Lack of sufficient financial resources	2	3.49	1.47	62.8	67.2	52.0	720.5	-0.414
Prohibitive costs	3	3.20	1.26	48.9	50.8	44.0	746.0	-0.162
Lack of skilled personnel	4	3.00	1.36	41.8	41.0	44.0	677.0	-0.832
Long return on investment	5	2.98	1.30	39.5	41.0	36.0	733.0	-0.287
Uncertainty in timing of innovation	6	2.40	1.40	31.0	30.0	33.3	704.5	-1.610
Lack of market consumption	7	2.29	1.59	27.9	29.5	24.0	750.5	-0.125
Lack of information on market opportunity	8	2.29	1.29	24.5	32.8	4.0	480.5	-2.795*
Lack of technological knowledge	9	2.26	1.27	20.9	19.7	24.0	739.0	-0.233
Lack of opportunities for cooperation with other firms	10	1.92	1.25	12.8	16.4	4.0	670.0	-0.960
Lack of technological opportunities	11	1.84	1.27	16.3	21.4	4.0	69.5	-0.687
Lack of R&D services	12	1.81	1.17	11.7	8.2	20.0	627.5	-1.440
Innovation control difficulties	13	1.72	0.99	5.9	8.2	0.0	723.5	-0.417
Resistance to change in the enterprise	14	1.66	1.07	9.3	8.2	12.0	647.5	-1.290
Legislation, norms, regulations, standards, taxation	15	1.63	1.09	9.3	9.8	8.0	731.5	-0.364
Deficiencies in the availability of external technical services	16	1.53	0.86	5.8	6.6	4.0	669.5	-1.048
No need to innovate due to earlier innovations	17	1.29	0.75	2.4	4.9	4.0	591.0	-2.539*

Total number of observation 86. Number of observation in metropolitan area = 61, in periphery = 25.

\* Significant at the 5% level. \*\* Significant at the 10% level.

**Table 3: Barrier and limitation factors: ranking according to the mean scores of the level of importance in the Traditional Industry**

Barrier and limitation factors to innovation	Rank	Mean Score	S.D	% of firms indicating the limitation factor as very significant or crucial			Mann-Whitney Test	
				Total firms	Firms in Metropolitan	Firms in Periphery	U	Z
Prohibitive costs	1	3.08	1.37	44.8	50.0	39.7	1735.0	-1.101
excessive perceived risk	2	3.02	1.47	40.8	37.1	44.4	1742.5	-1.063
Lack of sufficient financial resources	3	2.98	1.55	42.4	46.8	38.1	1860.0	-0.470
Long return on investment	4	2.96	1.35	37.6	42.0	33.3	1733.5	-1.109
lack of skilled personnel	5	2.87	1.38	37.1	31.1	42.9	1516.0	-2.075*
Lack of information on market opportunity	6	2.31	1.28	18.6	19.7	17.4	1914.5	-0.036
Lack of technological knowledge	7	2.10	1.14	13.6	11.3	15.9	1742.5	-1.090
Lack of market consumption	8	2.06	1.24	14.9	21.3	12.7	1575.5	-1.850**
Uncertainty in timing of innovation	9	2.04	1.19	10.5	13.1	8.0	1886.0	-0.188
Lack of opportunities for cooperation with other firms	10	1.97	1.08	11.4	15.0	7.9	1862.5	-0.148
Lack of R&D services	11	1.93	1.18	13.6	14.6	12.7	1656.0	-1.589
Innovation control difficulties	12	1.87	1.07	10.5	8.2	12.7	1747.5	-0.939
Legislation, norms, regulations, standards, taxation	13	1.80	1.26	12.9	18.0	7.9	1575.0	-2.004*
Deficiencies in the availability of external technical services	14	1.71	0.97	6.4	3.2	9.5	1494.0	-2.391*
Lack of technological opportunities	15	1.70	1.07	10.5	6.5	14.3	1845.5	-0.438
Resistance to change in the enterprise	16	1.65	1.03	8.9	3.3	14.3	1368.5	-3.210*
No need to innovate due to earlier innovations	17	1.47	0.85	4.0	6.5	11.1	1913.5	-0.500

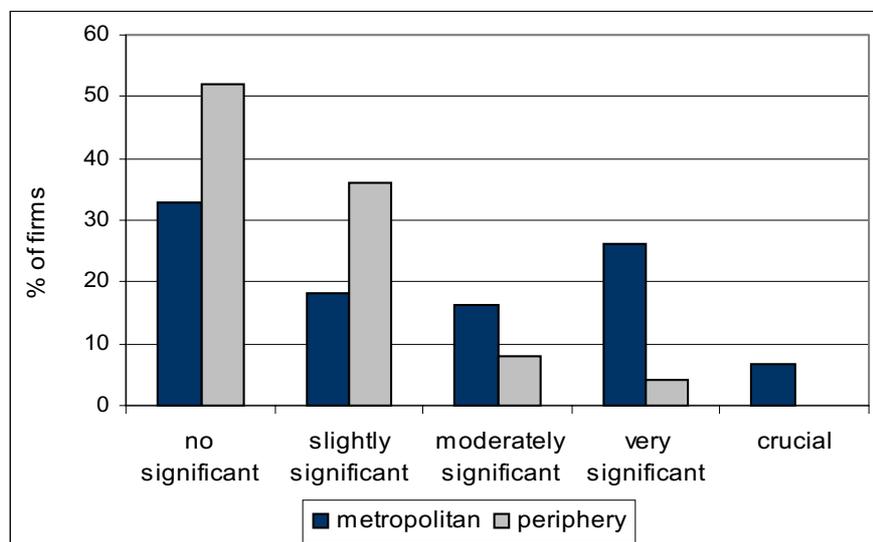
Total number of observation 125. Number of observation in metropolitan area = 62, in periphery = 63.

\* Significant at the 5% level. \*\* Significant at the 10% level.

factors and the relying on pull of highly skilled labor among these firms, and therefore emerge in the importance they ascribed to such factors.

In regarding to the hi-tech sector (see Table 2) almost no differences were found in accordance to location. Statistical significant differences exist between the hi-tech firms located in the metropolitan area and those in the periphery, only in two of the seventeen barriers from the list. Just one of them has certain important to innovation expressed by the lack of market information barrier that included in the medium importance group of factors. However, the importance of this barrier to the ability to innovate is much greater among hi-tech firms located in the metropolitan area, than in the periphery (see Figure 4).

*Figure 4: Distribution of hi-tech firms (%) according to the importance they ascribed to the lack of information on market opportunities as a barrier to innovation, by regions*



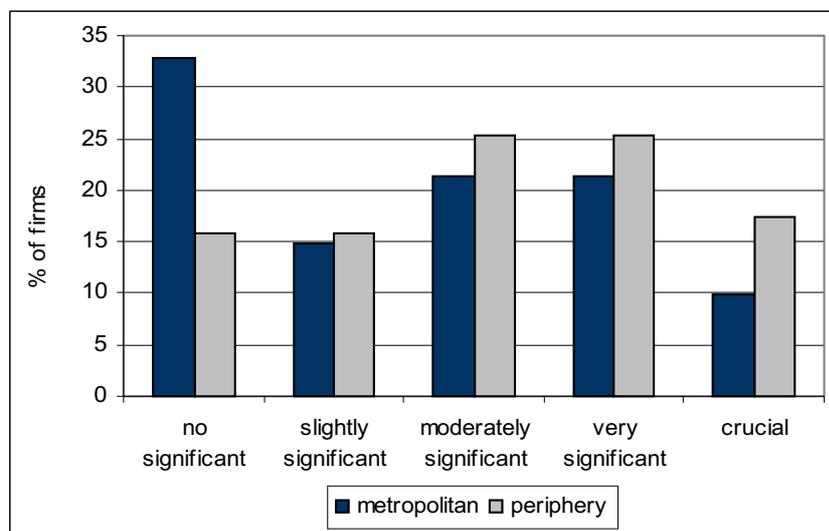
Although we can not assume that being located in the periphery improve the information sources on market, it does not for sure necessarily harm your information sources on potential markets. On the contrary, almost 50% of the hi-tech firms in the metropolitan area ascribed to this barrier at least moderate significant or more in limiting the ability to innovate, in contrast to only 12% of the firms in the periphery. This result probably connected to the fact that hi-tech firms located in the metropolitan area invest more in R&D and thereby developed new products (78.7% of the firms) than does the firms in the periphery (56% of the firms).

The result obtained from the traditional industry show much more differences between the firm in accordance to location. In five factors from the list of the ranked barriers, the differences between the importance ascribed by firms located in the metropolitan area and

firms located in the periphery, found to be statistical significant. However, only two of them belong to the first or second priority group of barriers. All the others gained very low mean score (less than 2.0) reflect the very limited effect they have on the ability to innovate.

The more important barrier in this context is the lack of skilled labor that as expected is more serious in the periphery, than in the metropolitan area (see Figure 5). 42.9% of the firms in the periphery indicate this barrier as very significant or crucial to the ability to innovate instead of 31.1% of the firms located in the metropolitan area.

*Figure 5: Distribution of traditional industries (%) according to the importance they ascribed to the lack of skilled personal as a barrier to innovation, by regions*



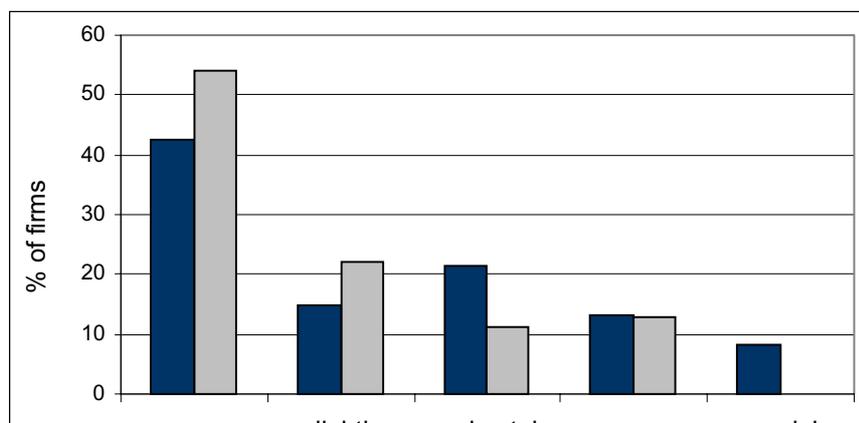
The importance of highly skilled labor pull to the regional innovativeness has been proved in many studies (Frenkel 2000, Ciccone and Hall, 1996). It is also evident that the absence of high skilled personal in the peripheral zones is more common than in the central areas. Nevertheless, it was interesting to convince that firms belong to the traditional industry, in particular in the peripheral zone, regards much more importance to the lack of highly skilled labor, than does firms that located in the more central areas. Similar findings did not emerge in the hi-tech firms in the sample. This is also exceptional due to the fact that traditional industries are based in large extent on nonprofessional and cheap labor. The explanation to this finding stems from the unique structure of the traditional industries located in the peripheral zone of the Northern region of Israel. In previous study (see Frenkel, 2000) it was found that the rate of traditional industrial firms engaged in innovation is higher among those that located in the peripheral zone, than in the metropolitan area. As such the distribution of

the traditional industrial firms in the sample show that the percent of the innovative firms in the periphery are 51% in contrast to only 31% among the firms in the metropolitan area. This is based on the large extent of the traditional industrial firms located in the northern periphery of Israel, who belong to the kibbutz sector. This sector had the willingness and the capability to allocate more financial resources to R&D, than did the private sector, thereby increase the technological level of traditional industrial firms owned by the Kibbutz sector. This fact apparently contribute to the high ranking of this barrier by the industrial traditional firms located in the peripheral zone against those that located in the metropolitan area. On the other hand the complexity of creating innovation in the hi-tech sector and the extremely importance they ascribed to highly skilled labor cross regional boundaries. Therefore this regarded as significant barrier to the development of innovation in the eyes of the hi-tech firms, without any connection to their spatial location.

The second important barrier to the success of innovation is the lack of market consumption to new products and processes. Here too the differences between the firms according to location in the importance they regarded to this factor found to be statistically significant. Traditional firms located in the metropolitan area ascribed much more significant to this barrier than does the firms in the periphery as depict in Figure 6.

Among the firms located in the peripheral region, 54% indicated no significant at all and 22% indicated only slightly significant to this barrier. On the other hand 43% of the firms located in the metropolitan area indicated to this factor moderately significant importance or more. This resultant probably from the specific structure of the traditional industry exists in the Northern region of Israel, as described above. With their larger engagement in innovation these firms located in the peripheral region based on new markets to their new products and processes. Conversely the firms belong to this industrial sector and located in the central area, focuses more on existing products and less on the development of new products. Therefore their requirements to identify new market is less, than the innovative firms in the periphery.

*Figure 6: Distribution of traditional industries (%) according to the importance they ascribed to the lack of market consumption as a barrier to innovation, by regions*



## **Discussion and Conclusions**

Analysis of various factors which constitute barriers to innovative success of industrial firms have shown the principal barriers that hindered the realization of innovation their. The importance in identifying these barriers tied to the need to determine an efficient public policy in order to deal with such limitations. Effective treatment that can remove these barriers will positively encourage the development of innovation and thereby contribute to the economic growth of the region. This is the essence of the legitimate base of government policy intervention where market forces are fail.

The results obtained from the analysis pointed to the high similarity in the principal barriers between the firms in accordance to their branch affiliation and spatial location. The significant limitations are those that regard to the highly risk involved with the engagement in innovation. This are related on one hand to the to the lack of financial sources, and on the other hand to the high cost needed for this engagement, thereby influence on the long return on such investment. Additionally the lack of highly skilled labor also found to be significant barrier in developing new products and processes. The great importance ascribed by the firms to these barriers where focused mainly in the hi-tech sector, yet in identical extent also in the traditional industry. Consequently these attributes must be used as strong pillars without doubt in any basis of public policy amid in supporting and encouraging the development of innovation, without direct relation to specific industrial sector.

Efficient public policy apparently could manage most of the attributes identify as principal barriers towards innovation. Thus, supportive incentive policy based on financial grants given to R&D activities could help in reducing the level of risk involved in the development of innovation. On this background it is worth to mark the significant R&D grants given by the OCS (Office of the Chief Science) in the Ministry of Industry and Commerce<sup>1</sup>. This become

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<sup>1</sup> The support is anchored in the Law Encouraging Industrial Research and Development-1984, aimed mainly at inducing the development of knowledge-based industry in Israel. R&D grants in Israel are based on a fixed rate

more relevant these days with the doubt that had been raised recently in the Israeli Ministry of Treasury on the necessity of the R&D grant policy, and the suggestion to cancellation or reduction the level of support given by the government. The findings obtained from the analysis in this study do not support this direction.

Farther more, no significant locational differences were found between the hi-tech firms in accordance to the effect on the level of risk, development cost and the lack of financial sources, on the ability of the firms to engage in innovation. Consequently there is not less need in determining government policy to handle such barriers in the metropolitan area, than in the peripheral regions. These findings also emphasis the great importance of the generous R&D grants given by the government to start-up firms<sup>1</sup>, without any location aspect, and the aid given to these firms in financing feasibility studies<sup>2</sup>.

Additionally, the result obtained from the analysis did not show significant locational difference in the importance ascribed by hi-tech firms to the absence of highly skilled labor. This barrier regarded as significant factor in hindering the engagement in innovation in any region and not in particular in the periphery as could be expected.

In contrast, significant statistical difference was found in the importance ascribed by hi-tech firm to the lack of market information, regarding to their location. This barrier towards innovation were found particularly significant in the metropolitan area, yet it can be ascribed to the highly engagement in innovation of the hi-tech firm in this region. Accordingly the importance of government policy in sharing the exporters' expenses by financing a marketing infrastructure of varying scale raised<sup>3</sup>. Since the high-tech industry is export oriented, the above aid track is most relevant for supporting the development of this industry.

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of 50% of the expense of an approved R&D program. The R&D aid program has also a regional aspect, since the fixed grant in peripheral areas is higher and accounts for 60% of the total expenses.

<sup>1</sup> The 1984 law encouraging industrial R&D determines a special track for supporting R&D in such plants by providing a larger grant (66%) of the eligible non-capital element of project cost, than to established plants (50%).

<sup>2</sup> Eligible grants are 50% of the total approved amount to conduct a feasibility study. The maximum budget is \$25,000-\$30,000.

<sup>3</sup> Participation in marketing expenses in 1/3 from the approved cost on building marketing infrastructure up to maximum 50,000-400,000\$, differs on a basis of exporter size.

In the traditional industries there were much more locational statistical significant differences in this perspectives. These differences obtained specifically from the unique structure of this industrial sector located in the northern periphery of Israel, where great part of the firms owned by the Kibbutzim. This ownership pattern creates relative advantage to these industries by given them preference in the investment in R&D and the capability and willingness to take risk in comparison to their competitors in the more central regions. The main difference that found to be statistical significant connected to the lack of highly skilled labor, as a limitation to the development of innovation, stressed more by firms located in the peripheral region. This is due to their great engagement in innovation in comparison to the firms located in the metropolitan area. Another significant statistical difference was found between the firms in accordance to location regard to the lack of market consumption to new products and processes. This limitation mainly stressed by the traditional firms in the metropolitan area.

The conclusions from this study in regards to public policy are also connected to the insignificant barriers in the development of innovation identified in the analysis. The possibility to receive R&D services everywhere emerges by the small importance ascribed to this factor as a barrier by the firms in the sample, regardless to their branch affiliation or location. This finding evidence to the great success of Israel in becoming an R&D laboratory on a worldwide scale, thus bring to removal this barrier. Another conclusion obtained from the findings is the irrelevant of traditional barriers to the development of innovation that in the past had great influence on locational choice of the industrial firms. In this context it is worth to remind the difficulties in the availability of external technical services, lack of opportunities for co-operation with other firms and technological institution and lack of technological opportunities. All of which in the globalization era and due to the high telecommunication progress lost their importance.

## Bibliography

- Alderman, N., (1985). Predicting Patterns of Diffusion of Process Innovation within Great Britain, paper presented to the Twenty-Fifth European Congress of the Regional Science Association, Budapest, Hungary, 27-30 August.
- Bertuglia, C.S., S. Lombardo, and Nijkamp (eds.) (1997). *Innovative Behaviour in Space and Time*. Berlin, Germany: Springer.
- Bertuglia, S.C., M.M. Fischer and G. Preto (eds.) (1995). *Technological Change, Economic Development and Space*, Berlin, Germany: Springer.
- Brophy, D., Shulman, J. (1993). "Financial factors which Stimulate innovation", *Entrepreneurship Theory and Practice*", Vol. 1, No. 2, pp. 61-76.
- Camagni, R.P. (ed.) (1991). *Innovation Networks: Spatial Perspectives*. London: Belhaven Press.
- Camagni, R.P. (1995). "The Concept of Innovative Milieu and Its Relevance for Public Policies in European Lagging Regions", *Paper in Regional Science*, Vol. 74, No. 4, pp. 317-340.
- Ciccone A, and Hall RE (1996) Productivity and the Density of economic Activity. *American Economic Review* 86 : 54-70.
- Davelaar, E.J. (1991). *Regional Economic Analysis of Innovation and Incubation* Aldershort, UK: Avebury.
- Davelaar, E.J. and Nijkamp, P. (1988). "The Urban Incubator Hypothesis: Re-Vitalization of Metropolitan Areas?" *The Annals of Regional Science*, Vol.22, No.3, pp.48-65 (special issue).
- Davelaar, E.J. and P. Nijkamp (1997). "Spatial Dispersion of Technological Innovation: A Review." pp. 17-40. in: *Innovative Behaviour in Space and Time*. C.S. Bertuglia, S. Lombardo, and P. Nijkamp (eds.). Berlin, Germany: Springer.
- Dosi, G., (1988). "Sources, Procedures, and Microeconomic Effects of Innovation", *Journal of Economic Literature*. Vol. XXVI, pp. 1120-1171.
- Erramilli, M. K., D'Souza, D.E. (1993). "Venturing into Foreign Markets: The Case of small Services Firms", *Entrepreneurship Theory and Practice*, Vol. 17, No. 4, pp. 29-43.
- Feldman, M.P. (1994). *The Geography of Innovation*. The Netherlands: Dordrecht, Kluwer Academic Publishers.
- Feldman, M.P. and A.S. Kutay (1997). "Innovation and Strategy in Space: Towards a New Location Theory of the Firm", pp. 239-250. in: *Innovative Behaviour in Space and Time*, C.S. Bertuglia, S. Lombardo and P. Nijkamp (eds.) Berlin, Germany: Springer.
- Felsenstein, D. (1996). "High Technology Firms and Metropolitan Locational Choice in Israel; A Look at the Determinants", *Geogr. Ann.* 78 A (1), pp.43-58.
- Freeman, C. (1974). *The Economics of Industrial Innovation*, Hamondsworth, Middx.: Penguin Books.
- Freeman, C., J. Clark and L. Soele (1982). *Unemployment and Technical Innovation: A Study of a Long Waves and Economic Development*, London: Frances Printer.
- Frenkel, A. (2000). "Can Regional Policy Affect Firms' Innovation Potential in Lagging Regions?" *The Annals of Regional Science*, Vol. 34, Issue 3, pp. 315-341.

- Frenkel, A. (2001). "Why High Technology Firms Choose to Locate in or near Metropolitan Areas", *Urban Studies*, Vol. 38, No. 7 (Forthcoming).
- Frenkel, A., Shefer, D., Koschatzky, K., Walter, G.H. (2001). "Firms Characteristics, Location and Regional Innovation: A Comparison Between Israeli and German Plants", *Regional Studies* (Forthcoming).
- Frenkel, A. Shefer, D, Roper, S. (2000) "Innovation, Public Policies and Locational Determinates of Hi-tech Industry: A Comparison between Israel and Ireland". Paper presented at the The 40th Congress of the European Regional Science Association, Barcelona (Spain), 29th August – 1st September, 2000.
- Frenkel, A., and D. Shefer (1997). "Technological Innovation and Diffusion Models: A Review." pp. 41-63. in: *Innovative Behaviour in Space and Time*. C.S. Bertuglia, S. Lombardo, P. Nijkamp (eds.). Berlin, Germany: Springer.
- Giersch, H. (ed.) (1995). *Urban Agglomeration and Economic Growth*. Berlin, Germany: Springer.
- Grossman, G.M. and E. Helpman (1990a). "Trade, Innovation and Growth." *American Economic Review*, Vol. 80, No. 2, pp. 86-91.
- Grossman, G.M. and E. Helpman (1990b). "Comparative Advantage and Long-Run Growth." *American Economic Review*, Vol. 80, No. 4, pp. 796-815.
- Grossman, G.M. and E. Helpman (1991). *Innovation and Growth in the Global Economy*, Cambridge, MA: MIT press.
- Grossman, G.M. and E. Helpman (1994). "Endogenous Innovation in the Theory of Growth." *Journal of Economic Perspectives*, Vol. 8, No. 1, pp. 23-44.
- Harrison, B., M.R. Kelley and J. Gant (1996). "Innovative Firm Behavior and Local Milieu: Exploring the Intersection of Agglomeration, Firm Effects and Technological Change", *Economic Geography*, Vol. 79, No. 3, pp. 233-258.
- Harrison, B., M.R. Kelley and J. Gant (1996). "Innovative Firm Behavior and Local Milieu: Exploring the Intersection of Agglomeration, Firm Effects and Technological Change", *Economic Geography*, Vol. 79, No. 3, pp. 233-258.
- Henderson, J.V. (1986). "Efficiency of Resource Usage and City Size." *Journal of Urban Economics*, Vol. 19, pp. 47-60.
- Henderson, J.V. (1988). *Urban Development: Theory, Fact and Illusion*. New York: Oxford University Press.
- Hoover, E.M. and Vernon, R. (1959). *Anatomy of Metropolis*, Cambridge, Mass.: Harvard University Press.
- Kleinknecht, A. and T.P. Poot (1992). "Do Regions Matter for R & D?" *Regional Studies*, Vol. 26, No. 3, pp. 221-232.
- Krugman, P. (1991). *Geography and Trade*, Cambridge MA: MIT Press).
- Krugman, P. (1995). *Development, Geography and Economic Theory*. Cambridge MA: MIT Press.
- Krugman, P.R. (1979) "A Model of Innovation, Technology Transfer, and Trade" *Journal of Political Economy*, Vol. 83, April, pp. 253-266.

- Matellato, D. (1997). "Innovation and Spatial Agglomeration", pp. 172-182, in: *Innovative Behaviour in Space and Time*, C.S. Berluglia, S. Lombardo, and P. Nijkamp (eds.), Berlin, Germany: Springer.
- Metcalf S., (1990), "On Diffusion, Investment and the Process of Technological Change", in: Deiac, E., Hornell, E., and Vickery, G., *Technology and Investment Crucial Issues for the 1990s*, London: Printer publisher.
- Nelson, R.R. (1986). "The Generation and Utilization of Technology: A Cross Industry Analysis". Paper presented at the Conference on "Innovation Diffusion", Venice, 17-21 March.
- Nelson, R.R. and S.G. Winter (1982). *An Evolutionary Theory of Economic Change*, Cambridge, MA: Bleknap Press, Harvard University.
- Nelson, R.R., and Winter, S.G., (1982). *An Evolutionary Theory of Economic Change*, Cambridge, MA.: Belknap Press Harvard University.
- Nijkamp, P. and J. Poot (1997) "Endogenous Technological Change, Long-Run Growth and Spatial Interdependence: A Survey." pp. 213-238. In: *Innovative Behaviour in Space and Time*, C.S. Bertuglia, S. Lombardo and P. Nijkamp (eds.) Berlin, Germany: Springer.
- Richardson, H.W. (1974). "Agglomeration Potential: A Generalization of the Income Potential Concept." *Journal of Regional Science*, Vol. 14, pp. 325-336.
- Romer, P.M. (1990). "Endogenous Technological Change." *Journal of Political Economy*, Vol. 98 (part 2), October, pp. S71-S102.
- Romer, P.M. (1994). "The Origins of Endogenous Growth." *Journal of Economic Perspective*, Vol. 8, No. 1, pp. 3-22.
- Roper, S., Frenkel, A. (2001). "Different Paths to Success? The Growth of the Electronics Sector in Ireland and Israel", *Environment and Planning C*, (forthcoming).
- Roper, S. and Love, J. (1996). "How Much Can Regional Policy Increase Firms' Innovation Capability?", paper presented to the 36th European Congress of the Regional Science Association, ETH Zurich, Switzerland, 26-30 August.
- Rosenberg, N. (1994). *Exploring the Black Box: Technology, Economics and History*, New York: Cambridge University Press.
- Rosenberg, N. (1985). "The Commercial Exploitation of Science by American Industry", In: Clarck, K.B., Hayes R.H., and Lorenz, C., (Eds.), *The Uneasy Alliance: Managing the Productivity-Technology Dilemma*, Cambridge M.A.: Harvard Business School Press.
- Rosenberg, N. (1972). *Technology and American Economic Growth*, New York: Harper and Row.
- Rosenberg, N. (ed.) (1976). *Perspectives on Technology*, New York: Cambridge University Press.
- Schmookler, J. (1966). *Invention and Economic Growth*, Cambridge, MA.: Harvard University Press.
- Schumpeter, J.,(1950). *Capitalism, Socialism and Democracy*, New York: Harper.
- Segal, D. 1976. "Are There Returns to Scale in City Size?" *Review of Economics and Statistics* 58:339-350.

Shefer, D. (1988). "The Effect of Various Means of Communication on the Operation and Location of High-Technology Industries." in: M. Giaoutzi and P. Nijkamp, (eds), *Informatics, High-Tech and Regional Development*, Aldershot, UK: Avebury, pp. 68-181.

Shefer, D., Frenkel, A, Koschatzky, K. and Walter, H.G. (2001), "Targeting Industries for Regional Development in Israel and in Germany – A Comparison Study". In: M.L. Lahr and R.E. Miller, *Regional Science Perspectives in Economic Analysis*, Elsevier Publisher Holland, (Chapter 13), Forthcoming.

Shefer, D., Frenkel, A. (1998). "Local Milieu and Innovativeness: Some Empirical Results" *The Annals of Regional Science*, No. 1, pp. 185-200.

Stokey, N.L. (1995). "R & D and Economic Growth", *Review of Economic Studies*, Vol. 62, pp. 469-489.