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Firm Characteristics, Location and Regional Innovation: A Comparison Between Israeli and German Industrial Firms

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FRENKEL A., SHEFER D., KOSCHATZKY K. and WALTER G. H. (2001) Firm characteristics, location and regional innovation: a comparison between Israeli and German industrial firms, *Reg. Studies* **35**, 415–429. In recent years, a growing number of researchers have been attempting to gain a better understanding of the variation in the rate of spatial innovation of different industrial plants. Several of these studies have investigated the similarity and dissimilarity of spatial innovation between countries. This paper reports the results of a large study carried out jointly by a team of researchers from Germany and Israel. In Germany, the study focused on Baden, the western part of the state of Baden-Württemberg; and in Israel, on the Northern district. Altogether in both countries, more than 400 industrial plants belonging to the fastest-growing industrial branches (electronics, metals and plastics) were included in the study. The use of simple statistical models, augmented by multi-variate logit models, enabled us to point out the similarity and dissimilarity in spatial innovation patterns in the two countries. The results support the hypothesis that expenditure on R&D is a good surrogate for the percentage of innovative firms among all firms in its sector, regardless of the industrial branch to which the plants belong. In general, we can conclude that there exists a strong similarity in the frequency of industrial innovation in both countries and that the share of innovative firms in the high-tech industries is significantly higher than in the traditional industries. On the other hand, the distribution of spatial variations in the share of innovative firms in Israel is greater than that found in Germany.

Spatial innovation Fastest-growing industries Industrial innovation High-tech industries Traditional industries

FRENKEL A., SHEFER D., KOSCHATZKY K. et WALTER G. H. (2001) Un profil des entreprises, la localisation et l'innovation régionale: une comparaison entre les entreprises industrielles israéliennes et allemandes, *Reg. Studies* **35**, 415–429. Dans les années récentes, un nombre croissant de chercheurs ont essayé de mieux comprendre la variation de l'innovation géographique des divers établissements industriels. Plusieurs études ont examiné la similarité et la différence de l'innovation géographique suivant le pays. Cet article cherche à présenter les résultats qui proviennent d'une étude détaillée conjointement faite par une équipe de chercheurs allemands et israéliens. En Allemagne, l'étude a porté sur Baden, la partie ouest de l'état de Baden-Württemburg, et en Israël, elle a focalisé sur la région du nord. Les deux pays confondus, on a inclus plus de 400 établissements industriels des secteurs industriels en pleine expansion (électronque, métaux et plastiques). L'emploi des modèles statistiques simples, augmentés par des modèles du type logit à variantes multiples, a permis de signaler la similarité et la différence de la distribution de l'innovation géographique dans les deux pays. Les résultats viennent à l'appui de l'hypothèse suivant: la dépense pour la R et D remplace efficacement le pourcentage des entreprises innovatrices d'un secteur donné, quel que soit le secteur d'activité en question. D'une manière générale, on peut conclure qu'il existe une similarité forte quant à la

FRENKEL A., SHEFER D., KOSCHATZKY K. und WALTER G. H. (2001) Firmeneigenschaften, Standort und regionale Innovation: ein Vergleich zwischen israelischen und deutschen Industriefirmen, *Reg. Studies* **35**, 415–429. In den letzten Jahren hat eine wachsende Anzahl Forscher sich um ein besseres Verständis für Schwankungen in der Rate räumlicher Innovation in verschiedenen Industriebetrieben bemüht. Einige dieser Studien haben Ähnlichkeiten und Abweichungen räumlicher Innovation zwischen Ländern untersucht. Dieser Aufsatz berichtet über die Ergebnisse einer groß angelegten Untersuchung, die von einer Forschungsgruppe aus Deutschland und Israel gemeinsam durchgeführt wurde. In Deutschland konzentrierte man sich auf Baden, den westlichen Teil des Landes Baden-Württemberg, und in Israel auf den nördlichen Landesteil. In beiden Ländern zusammen wurden über 400 Industriebetriebe der am schnellsten wachsenden Industriezweige (Elektronik, Metalle und Plastik) in die Untersuchung einbezogen. Die Anwendung einfacher statistischer Modelle, durch mehrfach variable Logitmodelle verstärkt, gestattete der Forschungsgruppe, in beiden Ländern die Ähnlichkeiten und Abweichungen bei räumlichen Innovationsmustern aufzuzeigen. Die Ergebnisse untermauern die Hypothese, daß Aufwendungen für Forschung und Entwicklung ein guter Ersatz für den Prozentsatz innovativer Firmen in der

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fréquence de l'innovation industrielle dans les deux pays, et que la proportion des entreprises innovatrices au sein des industries de pointe s'avère nettement supérieure à ce qu'elle ne l'est dans les industries traditionnelles. En outre, la distribution de la variation géographique de la part des entreprises innovatrices situées en Israël est supérieure à ce que l'on n'avait trouvé en Allemagne.

Innovation géographique
Industries en pleine expansion Innovation industrielle
Industries de pointe Industries traditionnelles

Gesamtzahl der Firmen in ihrem Sektor ist, ungeachtet der Industriebranche, der der Betrieb angehört. Im allgemeinen kann man folgern, daß in beiden Ländern starke Ähnlichkeiten bei industrieller Innovation zu beobachten sind und daß der Anteil innovativer Firmen in den Spitzentechnologiefirmen bedeutend höher ist als in den am Alten festhaltenden Firmen. Die Verteilung der räumlichen Schwankungen am Anteil innovativer Firmen ist jedoch größer in Israel als in Deutschland.

Räumliche Innovation
Am schnellsten wachsende Industrien
Industrielle Innovation Spitzentechnologieindustrien
Am Alten festhaltende Industrien

INTRODUCTION

In recent years there has been an increase in the number of empirical studies attesting to interregional variations in the rate of innovation, both within and between countries. International comparisons of the regional behaviour of industrial plants, and of the innovation processes characterizing them, are becoming increasingly important, following economic globalization and the transformation of the world into 'one small village' (SUAREZ-VILLA and HAN, 1990, 1991; ALDERMAN and FISCHER, 1992; NELSON, 1993; SUAREZ-VILLA and FISCHER, 1995; SUAREZ-VILLA and KARLSSON, 1996; SUAREZ-VILLA and RAMA, 1996; KLEINKNECHT, 1996; ROPER *et al.*, 1996). International comparison is particularly interesting in this study, since it compares the rate of innovation in a country with an established history of industrial innovation with a country that entered the innovation game relatively recently particularly in the high-tech sector.

The current study was motivated by the desire to test several related hypotheses concerning industrial innovation which emanate from the theoretical and empirical research that has been published in recent years. The purpose of this study was to identify the unique characteristics of different types of regions in Germany and Israel, and to test their ability to serve as incubators for innovation activities. Another aim was to investigate the specific conditions in the various types of sub-regions in Germany and Israel that might reduce industrial innovation. The results of this study will increase our knowledge of the innovation behaviour of firms located in different regions. Moreover, we believe that the findings may enhance our understanding of firm's innovation capability, and therefore contribute to the formulation of effective and efficient regional growth policies.

This paper is the result of a study carried out jointly by an Israeli team from the S. Neaman Institute for Advanced Research in Science and Technology at the Technion-Israel Institute of Technology, and a German team from the Fraunhofer Institute for Systems and Innovation Research located in Karlsruhe, Germany. The research was supported financially by the German-Israel Fund (GIF) for the sciences. The paper presents the results of a comparative analysis of empirical data gathered in both Israel and Germany. It enables an examination of the interregional and intraregional variations of innovation occurring in these countries as well as the differences and similarities in the factors affecting the creation of innovation from both the interregional and international perspectives. The analysis was based on data collected during field surveys conducted simultaneously in Germany and Israel. The paper focuses attention on product innovation as distinct from process innovation (for more on the latter point, see FRENKEL, 2000).

NATIONAL AND REGIONAL ASPECTS OF INNOVATION

The contribution of innovation to regional development is extensively reported in the literature discussing economic growth and development, which points out the significant role played by innovation in fostering regional economic growth (SUAREZ-VILLA, 1993; FELDMAN and KUTAY, 1997; DAVELAAR and NIJKAMP, 1997).

The burgeoning interest in the regional perspective of innovative activity is based on the recognition of the close link that exists among economic efficiency, competition and innovation (ROMER, 1990, 1994; BERTUGLIA *et al.*, 1995; NIJKAMP and POOT, 1997; BERTUGLIA *et al.*, 1997). This recognition led to a new regional policy designed to promote the adoption and creation of new technologies in existing plants, while at the same time encouraging the establishment of new high-tech firms (FELDMAN, 1994).

The development of a region as an incubator of innovations is generally accompanied by the appearance of new economic activity, market expansion and new technological applications. Such regions become a preferred destination for highly skilled labour, which is

attracted to migrate to them from other areas. These conditions promote development and in-migration of major corporate head-offices that subsequently impact on the region's educational infrastructure and auxiliary services (SUAREZ-VILLA, 1993). Innovation provides an infrastructure for the development of new firms by increasing market share, improving competitive edge and inducing economic growth. The assumption therefore follows that regions characterized by a high rate of innovation will enjoy greater economic growth than will other regions (GROSSMAN and HELPMAN, 1990, 1991, 1994; KRUGMAN, 1979, 1991, 1995; STOKEY, 1995; GEROSKI and MACHIN, 1992; KLEINKNECHT, 1996).

Studies analysing the path followed by new firms along the time–space dimension have concluded that this path generally commences in metropolitan areas, which serve as urban incubation sites for the emergence of innovative firms (HOOVER and VERNON, 1959; DAVELAAR and NIJKAMP, 1988). Empirical studies tend to support the hypothesis that companies located in large metropolitan areas have a significant advantage (THWAITES, 1982; CAMAGNI, 1984; FISCHER, 1989). The conditions offered by the concentration of economic activities in these areas, which contain the head-offices of large high-tech companies, R&D facilities, information centres and other elements, favour the generation of innovations. By contrast, peripheral regions are often characterized by a lower innovation capability (FISCHER, 1989; SWEENEY, 1987; FRENKEL, 1997).

Concomitantly, there have been reports arriving at precisely the opposite conclusions. For example, a study carried out in Holland presented surprising results with respect to the regional innovation potential of small and new firms (DAVELAAR, 1991). These results indicated the poor innovation potential of firms located in the Amsterdam and Rotterdam metropolitan regions. The study demonstrated that compared to the central regions, Holland's more peripheral areas were more promising from the perspective of attracting innovative firms. These findings, which are particularly valid for the Amsterdam metropolitan area, must be received with a degree of reservation, however, owing to the fact that the study sample involved only small industrial firms (DAVELAAR and NIJKAMP, 1988, 1992).

A study of innovation activities in the US focused on the variations between states (FELDMAN, 1994). The results point to a link between regional technological infrastructure and the rate of innovation of the region. The study identified four conditions necessary for a high rate of regional innovation: basic research carried out in universities; industrial R&D; concentration of firms; and concentration of business services. The positive impact of university research activities on the scope of innovation in a region is also supported by other studies (e.g. JAFFE, 1989; MANSFIELD, 1991). A concentration of firms also attests to innovation activity in a region, by indicating that technological progress generated during manufacturing processes leads to an increase in innovation outputs. This conclusion supports the hypothesis that 'learning by doing' constitutes an important input in the innovation process.

As has been shown by numerous studies, R&D activities are considered to be the most influential factor in a firm's ability to create innovation (THWAITES *et al.*, 1981; ROSENBERG, 1985; NELSON, 1986; DOSI, 1988; ROPER and LOVE, 1996; FRENKEL, 1997). Although various studies have indicated that R&D efforts tend to be concentrated in larger urban areas (MALECKI, 1979), a study conducted in the South East of the UK showed a large concentration of R&D employment in small urban areas (HOWELLS, 1984).

An international comparison of the regional distribution of R&D activity – in the US (the San Francisco Bay area, including Silicon Valley) and in the UK (Eastern England and Scotland) – showed a more significant concentration of R&D activity in the former (OAKEY, 1984). From the result of that study, however, it is apparent that Scotland cannot be categorized as a development region. The study also found that, in the UK, the peripheral region contained small independent firms that develop and generate innovation.

In-house R&D efforts as well as outsourced R&D services in Holland, were found to play a significant role in the generation of both product and process innovation (DAVELAAR, 1991). The importance of R&D in generating product innovation is also linked to location. R&D plays a more important role in creating innovation in the central than in the peripheral regions. The intermediate regions function as if positioned between the two. These results demonstrate the leading role of the metropolitan region in this context. In later stages of the product life cycle, however, the emphasis turns to improvements in manufacturing production, i.e. process innovation. Similar findings were also obtained in a study recently conducted in Israel (see SHEFER and FRENKEL, 1998).

In the empirical investigation of this study, a sample of more than 400 German and Israeli industrial firms was analysed. One of the objectives was to identify the innovation pattern of firms belonging to different economic sectors and located in different types of regions. The results of this analysis could enhance our understanding of the effect of various attributes of firms on their rate of innovation.

Empirical results obtained from various studies indicate that innovation activity is not limited solely to metropolitan or central regions (KOSCHATZKY, 1998). It is apparent that different regions play a unique role in the innovation processes as manifested by the spatial diffusion of innovation whether involving new products or production processes. Therefore, the ability of various regions to function in the long term is depend-

ent on their ability to complement rather than compete with each other. On the one hand, metropolitan areas are endowed with the economic environment necessary for the creation of industrial activities requiring advanced technological systems. On the other hand, these technologies are transferred in subsequent stages of the product life cycle to regions outside the metropolitan area – the knowledge spillovers effect. Because of the high cost of land, metropolitan areas are the preferred location for firms utilizing recently developed technologies, which can yield a high added value. By contrast, outlying regions are generally unable to provide the conditions necessary for the early product life cycle (MALECKI and NIJKAMP, 1988). It should be noted that a policy based on a uniform distribution of industries in space is liable to hinder and disrupt spatial specialization and thus efficiency. Such a policy could diminish the potential of some regions to grow in the long term (FRENKEL, 1997).

THE FRAMEWORK OF THE STUDY

Interregional comparison

The data collected in Germany and Israel on the spatial pattern of regional innovation was concerned with industrial firms in a selected number of fast-growing industrial branches (for more details on the methodology used in identifying fast-growing industries, see SHEFER *et al.*, 1998). These included the three major industrial branches: electronics (including optics and precise instruments); plastics; and metal products (these branches were included in this study).

Identification of fast-growing industries was based on an analysis of the rate of growth in output, employment and exports generated in each of the two-digit industrial branches. Industrial rates of growth serve as an indicator for defining the regional economic–employment potential. The assumption is that firms belonging to the fastest-growing industrial branches have a significant growth potential, and their impact on the region's economy will therefore be greater than that of firms belonging to declining industrial branches. Industries demonstrating significant export potential – in which the export component comprises a significant proportion of the branch's output – are more likely to grow than are industries that rely mainly on local markets (*ibid.*).

The study data were collected from field surveys conducted simultaneously in both countries from a randomly selected sample of firms. Questionnaires were constructed for gathering data at the level of the firm. Data concerning innovation activity, as well as information on such characteristics as ownership type, size, age and R&D activities, were included in the questionnaires.

In Israel, personal interviews were held with senior managers of each of the 211 firms included in the sample. This sample comprised approximately 72% of the firms of the region surveyed that were associated with the three selected industrial branches. In Germany, questionnaires were mailed to 1,502 plants belonging to the three fastest-growing industrial branches selected, located in the research region – the Baden part of the federal state of Baden-Württemberg. A total of 220 plants returned the questionnaires with the requested information. This sample comprised approximately 15% of the firms in the research region. The data set was controlled for branch, size and innovation bias by comparing the sample structure with a profile of the firms by using official statistics and other innovation surveys carried out in Baden-Württemerg or in sections of it. With respect to age, size distribution, R&D activity, and ownership type, it can be concluded that firms with up to 100 employees, which constitute over three-quarters of the sample, are most present in the region's industrial composition and innovation behaviour (KOSCHATZKY and TRAXEL, 1997).

A fundamental research question is linked to the spatial rate of innovations by industrial firms. For this reason, three types of sub-regions in each country were included in the study: metropolitan area; intermediate zone; and peripheral zone.

The Northern district of Israel is one of the country's most fascinating regions in terms of the composition of its inhabitants (Jews and non-Jews, veteran settlers as well as new immigrants), its settlements (type and pattern), and its landscape. In 1995, some 1·4 mllion people, constituting about 26% of the population of Israel, resided in that region, which extends for 5,000 km^2, accounting for 23% of the total land area of the state.

For this study, the Northern district was divided into three sub-regions: (1) the Haifa metropolitan area (central zone); (2) a surrounding intermediate zone (that is within acceptable commuting distance and contains the central and western Galilee); (3) a peripheral zone (that is removed from metropolitan influence and not within acceptable commuting distance). This last sub-region, which offers fewer employment opportunities as well as fewer social and commercial services, consists of eastern Galilee and all along the Jordan Valley, from Metula and Kiryat Shemona in the north to Beit She'an in the south-east (see Fig. 1a).

In Germany, the survey was carried out in Baden, the western part of the federal state of Baden-Württemberg, which is one of the most industrialized regions in Germany. It is characterized by a broad range of medium sized industrial plants and by large, internationally operating companies like Daimler-Benz, Porsche and Bosch. Major sectors found here are machinery, electrical and electronic equipment, transport equipment and metal products. The *Mittelstand* of Baden-Württemberg is seen as an important economic success factor of this federal state and termed a 'model region' (COOKE *et al.*, 1993). Baden-Württemberg

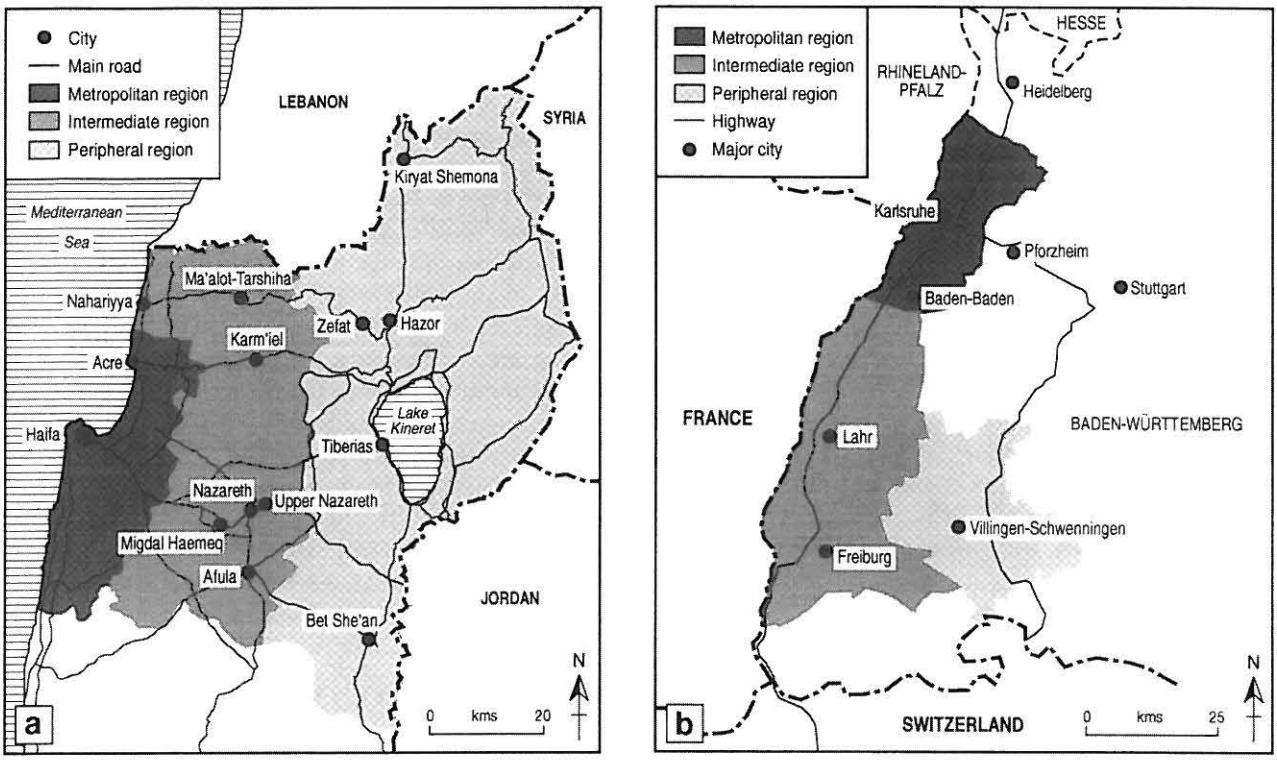

Fig. 1. *The two research regions and their sub-regions: (a) Northern region in Israel; (b) Baden region in the state of Baden-Württemberg*

consists of 12 planning regions; three of them were included in the current study (see Fig. 1b). In 1995, these three regions contained 2·4 million people, comprising about 23% of the population of Baden-Württemberg. According to the 1991 classification of the German Federal Agency for Construction and Regional Planning, used for official planning purposes, the three regions represent the three types of sub-regions used in the current study: (1) the Karlsruhe metropolitan area – *Mittlerer Oberrhein* (central area); (2) the Südlicher Oberrhein – Freiburg area (intermediate zone); and (3) Schwarzwald-Baar-Heuberg (the peripheral area). These sub-regions were classified according to characteristics like centrality, agglomeration and location (BUNDESAMT FUER BAUWESEN UND RAUMORDNUNG (BBR), 1998). Although the criteria used for this classification might not apply to the Israeli context, they allow for a clear distinction among central, intermediate and peripheral areas within Germany. It must be pointed out that these three types of regions, compared to those in Northern Israel, differ in economic structure, public infrastructure supply and openness. Nevertheless, it is interesting to compare the differences and similarities in the spatial innovative behaviour of firms belonging to fast-growing industrial branches in the two countries.

Table 1. *Distribution of population and employment among sub-regions in Israel and Germany 1995*

Type of zone	Country	Population size		% of employees	% of manufacturing employees
		No.	%		
Metropolitan area	Israel	575·3	40·0	62·3	46·3
	Germany	952·6	39·8	42·1	39·1
Intermediate zone	Israel	628·4	43·7	26·8	40·5
	Germany	963·8	40·3	38·4	34·9
Peripheral zone	Israel	235·0	16·3	10·9	13·3
	Germany	474·4	19·9	19·5	26·0
Total	Israel	1,438·7	100·0	100·0	100·0
	Germany	2,390·8	100·0	100·0	100·0

Sources: Israel, ISRAEL CENTRAL BUREAU OF STATISTICS, 1996; Germany, STATISTISCHES LANDESAMT BADEN-WÜRTTEMBERG, 1997, Statistisches Taschenbuch 1997, Stuttgart: Offizin Chr. Scheufele. The Israeli data is an estimation based on an analysis of the Central Bureau of Statistics (CBS) manpower survey of urban settlements with more than 10,000 residents (thus covering more than 70% of employees in the area).

Table 1 shows a comparison of the two research regions. The population of the German research area is 1·7 times larger than the Israeli area; however, the relative share of the population in each of the three types of sub-regions is similar in both countries. By contrast, the overall distribution of the employed population differs significantly. A larger percentage of employment opportunities is offered in the Haifa metropolitan area than in the Karlsruhe area. In Israel, though, the percentage of employees drops sharply and significantly when moving out of the metropolitan area towards the intermediate zone, and again from there to the peripheral area; by comparison, Germany has a more equitable distribution of employment among the three regions. In Israel, a larger percentage of manufacturing employment can be found in the central and intermediate regions. This is due to the fact that, in recent years, this zone has been undergoing a transformation, attracting a relatively large number of new industrial plants. The trend is reflected in the high proportion of young firms that have been set up in this sub-region (see Table 1), a phenomenon that is linked to the availability of land for the development and expansion of firms, the development of such needed infrastructures as road and communications networks, and the relative proximity of this region to a large pool of highly skilled labour residing on the outskirts of the metropolitan area. In Germany, the distribution of manufacturing employment in the three sub-regions is similar to that found in Israel, with the exception of the peripheral zone of Baden, where a larger percentage of manufacturing employees can be found than in its counterpart in Israel. This situation illustrates the fact that the peripheral zone in Germany is not a pure peripheral area as is the case in Israel. In Israel, the peripheral zone is 'hermetically sealed' to the neighbouring countries, whereas the comparable zone in Germany has immediate access to one of Western Europe's major traffic junctions, near Basle, and to the open common border between Germany, Switzerland and France.

Table 2 shows the distribution of industrial firms in the two samples according to sub-region and industrial branch. In addition to variations in the overall distribution of industrial firms in each country, the data also point to differences in the distribution of firms by industrial branch. Thus, the electronics industry predominates the sample in Israel's Haifa metropolitan area (54·4%), whereas the metal industry dominates the Karlsruhe metropolitan area (40·7%) in Germany. In both countries, electronics dominate the intermediate zones (41·5% in Israel and 56·7% in Germany). Israel's peripheral zone is distinguished by the predominance of the plastics industry (57·1%), a phenomenon that is linked to the concentration of *kibbutzim* in the peripheral area and to the prevalence of plastics firms among *kibbutz* industries. In the peripheral region of Baden, industry has a polarized branch structure. The plastics industry is significantly limited (only 7·5%) in this region, which is dominated primarily by the metal industry (50·0%) closely followed by the electronics industry (42·5%). It can be assumed that the spatial variations in the regional distribution of these industries in the two countries are likely to impact on the rate of regional innovation in each of the sub-regions.

INNOVATION PATTERNS

Several studies distinguish between product and process innovation. During some stages of the product life cycle, it becomes increasingly difficult and expensive to innovate and substantially improve new products. When this stage is reached, innovation efforts are directed more towards improving production techniques; i.e. process innovation (DOSI, 1984; DAVELAAR, 1991). A low regional economic capacity, while constituting a constraint on the innovation of new products, still allows for the diffusion of innovative production processes (ALDERMAN, 1990). Firms adopt process innovation by purchasing it in the marketplace, similar to purchases of other production inputs. By contrast, product innovation is protected, both structurally and conceptually, since it is a vehicle for gaining superiority over a firm's competitors.

Since the current study focuses on product innovation, we define innovative firms as those that have created innovative products during the past three years. Included in this definition are activities leading to the development of new products, the adoption of products that are new to the market, and the substantial improve-

Table 2. Distribution of firms by industrial branch, country and sub-region (%)

Industrial branch	Country		Sub-region					
			Metropolitan		Intermediate		Periphery	
	Israel	Germany	Israel	Germany	Israel	Germany	Israel	Germany
Electronics	40·8	44·5	54·4	35·2	41·5	56·7	25·4	42·5
Plastics	37·9	12·7	22·7	24·1	35·4	11·7	57·1	7·5
Metals	21·3	42·7	22·7	40·7	23·2	31·7	17·5	50·0
Total	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0
N	211	220	66	54	82	60	63	106

ment of existing products (development of the next generation of products). These activities emanate either from in-house investments in R&D or from the purchase of know-how through outsourced R&D services. Firms that dealt exclusively with developing or adopting innovative processes or with adopting new products not requiring R&D investment were not classified in this study as innovative firms.

Regional variations in industrial innovation patterns in Germany and Israel are reflected in the frequency of innovation shown by firms in each of the defined sub-regions. Analysis of the two samples points out different locational patterns of firms according to industrial sector. The results suggest that it would be appropriate to examine the impact of the industrial sector on the rate of regional innovation, while categorizing firms into two basic industrial groups on the basis of their technological character. The first group, representing the high-tech industries, includes electronics, electro-optics, optics and precision instruments. The second group represents the more traditional industries – plastics and metal products.

The reasons for this division are also connected to the relatively small number of plants affiliated with the metal products industry in the Israeli sample, and affiliated with the plastics industry in the German sample. The similarity in behaviour between the traditional industrial sectors (plastics and metal products), on the one hand, and the difference between those industries and the high-tech industries, on the other hand, also lend justification to this grouping. Furthermore, numerous variations have been found in the innovative properties characterizing these two industrial groups. The difference is reflected in the high expenditure on R&D made by the high-tech industries compared with those made by the traditional industries. Table 3 presents the results of the statistical analyses of several selected variables measuring the extent of R&D activities in the firms surveyed. The results show that a significant difference exists among the various industrial branches. When a similar analysis was conducted only of the plastics and metal products industries, no statistical difference was observed. It is for this reason that we decided to stratify the industries into two major groups – high-tech, and traditional.

Innovation activity is a prerequisite for high-tech firms. These firms must therefore invest in R&D, including basic research, and are obliged to engage highly skilled labour in order to cope with complex technological problems. By contrast, innovation is not as essential to firms in the traditional industries, in which it is chiefly linked to process innovation, aimed primarily at improving production processes.

The distribution of innovative firms, when categorized into the two industrial groups, demonstrates a strong similarity between the two countries, with regard to both the prevalence of innovation in the firms sampled and their regional behaviour (see Tables 4 and 5). A significantly high percentage of innovative firms is to be found among the high-tech industries of both Israel and Germany (77·2% and 74·4%, respectively). By contrast, there is a much lower percentage of innovative firms among the traditional industries in Israel, and a still lower percentage in Germany (49·6% and 36·5%, respectively). This difference between the two countries is statistically significant at the 0·05 level.

An interregional comparison of high-tech firms showed no significant differences between the percentage of innovative firms in the two countries. An interregional comparison of innovation by traditional industrial firms, however, showed a significant difference between the two countries. The percentage of innovative firms affiliated with traditional industries located in the metropolitan and intermediate sub-regions of the two countries is very similar. By contrast, in the Israeli peripheral area, there is a much higher percentage of innovative firms (almost double Germany's rate).

Table 3. Labour and R&D inputs, ANOVA between industrial groups

Industrial group	% highly skilled labour	% R&D workers	% R&D expenditure	R&D expenditure ($m)
Electronics	25·9 (183)[1]	17·7 (175)	14·2 (170)	2·46 (161)
Plastics	6·9 (104)	3·4 (98)	2·0 (94)	0·14 (88)
Metal	4·8 (138)	3·1 (128)	3·0 (124)	0·25 (107)
F value	25·61	48·96	28·18	7·31
P	0·0000	0·0000	0·0000	0·0011

Note: 1. Number of observations in brackets.

Table 4. Distribution of high-tech industrial firms by innovation and location in Israel and Germany (%)

	Country		Israeli sub-regions			German sub-regions		
Innovation	Israel	Germany	Metropolitan	Intermediate	Periphery	Metropolitan	Intermediate	Periphery
Innovative firms	74·4	77·2	88·9	67·6	56·3	94·1	77·4	70·5
Non-innovative firms	25·6	22·8	11·1	32·4	43·8	5·9	22·6	29·5
Total	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0
N	86	92	36	34	16	17	31	44
χ^2	0·1842			7·553			3·899	
P	0·671			0·023			0·140	

Table 5. Distribution of traditional industrial firms by innovation and location in Israel and Germany (%)

	Country		Israeli sub-regions			German sub-regions		
Innovation	Israel	Germany	Metropolitan	Intermediate	Periphery	Metropolitan	Intermediate	Periphery
Innovative firms	49·6	36·5	36·7	45·8	61·7	35·3	50·0	31·6
Non-innovative firms	50·4	63·5	63·3	54·2	38·3	64·7	50·0	68·4
Total	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0
N	125	115	30	48	47	34	24	57
χ^2	4·172			5·033			2·503	
P	0·039			0·079			0·286	

An examination of the interregional variations in each of the countries, as presented in Tables 4 and 5, points to the existence of a trend in regional behaviour with regard to innovation in the two industrial groups; the trend is particularly strong in Israel. This is the significant decrease in the percentage of innovative firms in the high-tech industry as one progresses from the metropolitan area to the intermediate zone, and from there to the periphery. The interregional differences are statistically significant (at the 0·05 level). The inter-area variations are smaller in Germany (especially between the intermediate and peripheral areas) and are not statistically significant. A reverse regional trend has been observed in Israel's traditional industries, with the percentage of innovative firms increasing with the movement from the metropolitan area to the intermediate zone, and from there to the periphery. These particular regional differences are of moderate statistical significance. In Germany, the percentage of innovative firms characterizing traditional industries is higher in the intermediate zone than in the metropolitan and the peripheral areas; however, the differences are not statistically significant.

The impact of the firms' organizational structure on their propensity to innovate is greater in Germany than in Israel. In both countries, the percentage of innovative firms among multi-plant companies is higher than among single-plant firms (see Table 6). Similar results were obtained in studies carried out in the UK (see GEROSKI and MACHIN, 1992; and ROPER and LOVE, 1996). This variation in the percentage of innovative firms according to organizational structure is statistically significant in Germany, but not so in Israel.

It should be noted that a statistically significant association was found in Israel between industrial sector and ownership type. A high percentage of firms owned by *kibbutzim* belong to the traditional sector (76·1%). Also a statistically significant association was found between industrial sector and organizational structure. In both countries, the multi-plant structure is prevalent in the high-tech sector (73·8% in Israel and 59·3% in Germany), while single firms predominate in the traditional sector (67·5% in Israel and 61·3% in Germany).

The importance of R&D as a major factor inducing innovation has been shown in many studies, including the present one. The results presented in Table 7 demonstrate the statistically significant relationship between the percentage of innovative firms and firms' R&D activities, as expressed in the number of R&D employees and expenditure on R&D. In both countries, a high percentage of the innovative firms (over 90%) employ more than five R&D employees. Compared to Israel, the R&D activity in innovative firms

Table 6. Distribution of firms by innovation and organizational structure in Israel and Germany (%)

	Israel		Germany	
Innovation	Single-plant	Multi-plant	Single-plant	Multi-plant
Innovative firms	57·4	69·0	46·7	75·0
Non-innovative firms	42·6	31·0	53·3	25·0
Total	100·0	100·0	100·0	100·0
N	169	42	150	56
χ^2	1·898		13·19	
P	0·165		0·000	

Table 7. Distribution of firms by innovation and number of R&D employees in Israel and Germany (%)

	No. of employees in R&D: Israel				No. of employees in R&D: Germany			
Innovation	0	1–4	5–9	10 +	0	1–4	5–9	10 +
Innovative firms	4·5	77·9	89·3	94·7	15·8	67·1	92·3	100·0
Non-innovative firms	95·5	22·1	10·7	5·3	84·2	32·9	7·7	0·0
Total	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0
N	66	77	28	38	76	73	13	37
χ^2	123·3				89·23			
P	0·000				0·000			

Table 8. Distribution of firms by innovation and investment in R&D in Israel and Germany

	Investment in R&D ($m): Israel				Investment in R&D ($m): Germany			
Innovation	0	0·01–0·1	0·1 – 0·5	0·5 +	0	0·01–0·1	0·1–0·5	0·5 +
Innovative firms	3·3	64·9	94·9	94·3	5·1	88·0	89·7	95·7
Non-innovative firms	96·7	35·1	5·6	5·7	94·9	12·0	10·3	4·3
Total	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0
N	61	37	54	35	59	25	39	46
χ^2		124·7				122·6		
P		0·000				0·000		

Table 9. Distribution of firms by size and innovation in Israel and Germany (in %)

	Size (no. of employees): Israel			Size (no. of employees): Germany		
Innovation	< 20	20–99	100 +	< 20	20–99	100 +
Innovative firms	67·6	64·3	76·3	45·9	54·0	87·0
Non-innovative firms	32·4	35·7	23·7	54·1	46·0	13·0
Total	100·0	100·0	100·0	100·0	100·0	100·0
N	37	115	59	61	100	46
χ^2		2·56			20·12	
P		0·277			0·000	

Table 10. Distribution of firms by age and innovation in Israel and Germany (in %)

	Age of firm: Israel				Age of firm: Germany			
Innovation	< 1969	1970–79	1980–89	1990 +	< 1969	1970–79	1980–89	1990 +
Innovative firms	73·3	66·1	63·8	74·3	60·6	58·8	59·6	44·4
Non-innovative firms	26·7	33·9	36·2	25·7	39·4	41·2	40·4	55·6
Total	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0
N	45	62	69	35	59	25	39	46
χ^2		1·89				1·67		
P		0·595				0·643		

in Germany, based on the number of R&D employees in a firm, appears to rely more on outsourced R&D services, and less on in-house R&D activity. In Germany, 10·9% of all innovative firms do not employ R&D employees at all, compared with only 2·4% of such firms in Israel.

Analysis of the data presented in Table 8 supports the hypothesis that a statistically significant association exists between innovation activities and expenditures on R&D. The data indicate that most of the German firms which invested in R&D were product innovative. In Israel, on the other hand, only 65% of the firms with an R&D expenditure of $100,000 per annum or less engage in innovation. A large proportion of the remaining firms (35%) engaged in process innovation rather than in product innovation. (This latter group as mentioned earlier, was not included among the innovative firms as defined in this study.) In general, it may be concluded that there are only small differences between Germany and Israel in R&D expenditures. In Israel, the median of annual expenditure on R&D is $329,000 per firm, compared with $395,000 in Germany.

A firm's size, as measured by the number of employees, was found to have a significant impact on the propensity to innovate in Germany, but not so in Israel (see Table 9). In Germany, large firms tended to engage in innovation more than medium and small size firms.

In both countries, a firm's age was not found to have a significant effect on the rate of innovation, as shown in Table 10. This finding does not corroborate the results obtained in several other studies (NABSETH and REY, 1974; MALECKI, 1977; OAKEY *et al.*, 1980; THWAITES *et al.*, 1981).

MULTIVARIATE ANALYSIS

The models used

The results obtained with the logit model pointed out differences between the two countries. The logit model is a binary choice model that assumes two mutually exclusive alternatives. In the current case, the choices are either to engage in innovation or not to engage. The choice may be influenced by a firm's internal

attributes, such as sector affiliation, expenditure on R&D, ownership type, size and age as well as its location and production milieu (SHEFER and FRENKEL, 1998).

The variables used in the model designed to explain the probability of a firm's engaging in innovation may be classified into three groups:

1. *Basic variable*
- *Location variable* – divided into three sub-regions: metropolitan area, intermediate zone and peripheral area. We hypothesized that firms located in or near metropolitan areas are *ceteris paribus* more innovative.
- *Sector affiliation* – categorized into two types of industrial groups: high-tech industries and traditional industries. We hypothesized that firms belonging to high-tech industries are more innovative, *ceteris paribus*.

2. *Characteristics of firm*
- *R&D activity* – the assumption is that innovation is, to a large extent, positively related to the existence of R&D activities. The variables used to measure the scope of this activity are related to the firm's annual expenditure on R&D or to the number of its employees engaged in R&D.
- *Organizational structure* – the firms in the two samples were divided into two principal groups: multi-plant and single-plant. It is hypothesized that multi-plant firms are more innovative than single-plant ones.
- *Age of firm* – it is hypothesized that newer firms among the high-tech industries are more innovative compared with older firms, and that the situation is reversed among the traditional industries. The age of a firm is a continuous variable, i.e. number of years. Although the firm's age was not found to have significant impact on innovation in our simple, partial statistical analysis (see Table 10), we decided to include this variable in the model in view of the positive results obtained in previous studies.
- *Size of firm* – plant size was measured according to the number of employees. The sample of firms was divided into three groups: small firms up to 20 employees; medium sized firms, with 20–99 employees; and large firms, employing more than 100 workers. We hypothesized that large firms are more innovative than are small firms, *ceteris paribus*.

3. *Production milieu*. The impact of the production milieu on the rate of innovation was examined by means of agglomeration indices computed for the various sub-regions (for a description of the computation, see SHEFER and FRENKEL, 1998). Since the geographical sizes of the sub-regions are not identical, the absolute size of the population does not constitute an index of the relative concentration of economic activities. We therefore decided to use population density as a surrogate measure of concentration, thereby cancelling out differences in the geographical size of each sub-region.

We assumed that the agglomeration effect follows an exponential function; therefore, the agglomeration index was computed by squaring the population density variable in each sub-region (SHEFER, 1987, also used this method; see also MOOMAW, 1983; CICCONE and HALL, 1996; SHEFER and FRENKEL, 1998).

The logit model was applied separately to the two groups – the high-tech and the traditional industries – while constructing dual nation models incorporating the data from the two countries. These models allowed us to examine the impact of each of the above-mentioned variables on the probability of a firm engaging in innovation. In order to statistically test the differences between Germany and Israel, we introduced a dummy variable. A value of 1 was assigned for firms in the German sample, and a value of 0 for firms in the Israeli sample.

Six of the models estimated are presented in Table 11. Three divisions were used in their analysis. First we classified the six models into two mutually exclusive groups: (a), (b) and (c) present the results obtained when applying the data from firms belonging to the high-tech industries, models (d), (e) and (f) present the results obtained when applying the data from the firms belonging to the traditional industries. Second, we used two alternative measures of R&D activity. Models (a) and (d) include the overall expenditure on R&D, measured as a percentage of the firm's annual turnover. This variable includes both in-firm expenditures and expenditures on outsourced R&D services. Models (b) and (e) include only expenditures on in-house R&D, measured by the percentage of a firm's employees engaged in R&D. This approach allowed us to conduct analyses similar to ones conducted in previous studies (THWAITES, 1982; OAKEY, 1984; DAVELAAR, 1991). Third, we introduced into the two remaining models, (c) and (f), an additional variable measuring the extent of the production milieu. This variable is the agglomeration index (a surrogate for the production milieu) and replaces the locational dummy variable representing the sub-regions in the previous models. Since a high correlation exists between the sub-regions' locations, the dummy variables and the computed agglomeration index, we have decided to avoid multicollinearity and so obtain more efficient and reliable estimations by excluding the location dummy variables in these two latter models and using instead the agglomeration index.

The *t*-values, presented in parentheses in Table 11, indicate the level of statistical significance of each of the estimated coefficients, as well as the direction and scope of the effect of the variable. The overall strength of the model is also presented in the table by means of the final likelihood obtained; p^2 is an informal goodness-of-fit that measures the fraction of an initial log likelihood value explained by the model; and $\bar{p}^2$ is a goodness-of-fit connected to the number of parameters estimated (see BEN AKIVA and LERMAN, 1985, p. 91).

Table 11. Logit model results for the dual-nation model analysis (t-value in parentheses)

Independent variables	High-tech industries			Traditional industries		
Variable	Model (a)	Model (b)	Model (c)	Model (d)	Model (e)	Model (f)
Constant	−5·565	−4·575	−5·932	−3·115	−4·019	−4·087
	(−2·66)*	(−3·22)*	(−2·68)*	(−4·87)*	(−5·59)*	(−5·25)*
R&D expenditures***	1·225	0·394	1·228	0·161	0·226	0·229
	(4·44)*	(4·62)*	(4·48)*	(3·32)*	(4·74)*	(4·79)*
Germany	3·288	1·665	3·878	–	–	–
(yes)[1]	(2·18)*	(1·79)**	(2·04)*	–	–	–
Location in Israeli	2·641	1·450	–	−1·120	−1·647	–
metropolitan area (yes)[1]	(2·03)*	(1·60)**	–	(−2·06)*	(−2·70)*	–
Location in German	–	–	–	0·731	0·913	0·886
intermediate zone (yes)[1]	–	–	–	(1·41)	(1·72)**	(1·66)**
Size of firms (large = 3,	0·958	1·272	0·993	1·050	1·338	1·364
medium = 2, small = 1)	(1·27)	(2·35)*	(1·27)	(3·50)*	(4·187)*	(4·20)*
Age of German firms	−0·408E-01	−0·256E-01	−0·434E-01	–	–	–
(number of years)	(−1·39)	(−1·70)**	(−1·41)	–	–	–
Age of Israeli plants	–	–	–	0·461E-01	0·494E-01	0·558E-01
(number of years)	–	–	–	(2·90)*	(3·01)*	(3·02)*
Israeli multi-plants	−0·769	−0·771	−0·893	0·279	0·526	0·646
(yes) (1)	(−0·56)	(−0·86)	(−0·66)	(0·23)	(0·44)	(0·53)
German multi-plants	1·646	2·085	1·670	0·198	0·300	0·218
(yes) (1)	(1·02)	(1·65)**	(1·05)	(0·34)	(0·48)	(0·34)
Index of Israeli	–	–	0·321E-05	–	–	−0·205E-05
agglomeration	–	–	(2·00)*	–	–	(−2·82)*
Index of German	–	–	−0·379E-05	–	–	0·982E-06
agglomeration	–	–	(−0·33)	–	–	(0·31)
N	167	172	167	203	207	207
Initial likelihood	−115·75	−119·22	−115·75	−139·17	−143·48	−143·48
Final likelihood	−23·23	−40·54	−23·27	−115·74	−108·48	−107·94
ρ^2	0·80	0·66	0·80	0·18	0·24	0·25
$\bar{\rho}^2$	0·75	0·57	0·75	0·17	0·24	0·24

Notes: 1. Dummy variable, reference group in parentheses.

*Significant at $p < 0·05$.

**Significant at $p < 0·10$.

***In models (a), (c) and (d) = % R&D expenditures of total revenue; in models (b) (e) and (f) = % R&D employees.

Empirical results

The high-tech industries. As hypothesized, the results of the three models – (a), (b) and (c) – indicate the dominant and positive effect of the R&D variable on the probability of generating innovation. In the comprehensive R&D model – (a) and (c) – in addition the country dummy variable was found to be statistically significant. This means that, all other things being equal, a high-tech firm in Germany has a slightly higher probability of generating innovation than it does in Israel. The location variable constitutes an additional difference between the two countries. In Israel, a firm located in the metropolitan area has a greater probability of generating innovation; no such locational effect was observed in Germany.

Based on the results obtained from the application of model (b), we may conclude that the percentage of persons engaged in R&D in both countries positively impacts the probability of generating innovation. Significant differences between the two countries, however, were found for the other variables. In this case too, an Israeli high-tech firm located in a metropolitan area has a statistically significant higher probability of generating innovation. In model (b) the impact of the size of the firm (scale effect) on the probability of generating innovation was found to be similar in both countries. The increase in the probability that large firms will develop innovation may be due to the fact that they are more likely to procure sources of capital for financing R&D expenditure and that they have a greater ability than small firms to take risks.

By contrast, a significant difference between the two countries was found in the effect of plant age. In Germany, the age effect was negative and statistically significant; in other words, younger firms in Germany have a greater probability of developing innovation. No such effect was detected in Israel. This finding may be explained by the fact that, unlike Germany, where there is a broad age distribution of firms, a very large proportion of Israel's high-tech firms are relatively young firms, established in the late 1970s and early 1980s. An additional effect, similar to the one obtained in the second model, is linked to the organizational structure of the plants. In this case as well, the effect of the variable is statistically significant in Germany, but not in Israel. In Germany, firms belonging to

multi-plant companies are more likely to develop innovation than are single-plant firms. The likelihood obtained in both models is good, and the level of explanation is quite high, particularly in the more complete (a) model.

The results of the application of model (c) show a statistically significant and strong positive effect, which the agglomeration variable exerts on the probability of generating innovation in Israel. It was found that only one other variable – namely, R&D expenditure – makes such a significantly positive contribution towards the development of innovation. The result obtained further reinforces the conclusion that in Germany, unlike Israel, location has very little impact on the probability of generating innovation. This result may be partly explained by the smaller variation in the agglomeration indices calculated for each of the sub-regions in Germany, compared with the wide variations observed in Israel. This is particularly seen when we compare the agglomeration indices calculated for the intermediate zone of Freiburg with the peripheral area of Baden. The agglomeration index calculated for the metropolitan area of Karlsruhe, however, is double the indices calculated for the two other areas. Nonetheless, this variable has not been found to influence the probability of generating innovation in German high-tech firms.

The traditional industries. The results obtained from applying models (d), (e) and (f) using the data from firms affiliated with traditional industries show a number of variables that affect the probability of generating innovation, particularly in Israel. The overall level of explanations obtained from these models is less than the level obtained from the high-tech industries.

Here, too, the expenditure on R&D variable has a significant and dominant impact on the probability of generating innovation. This impact, which is positive, is highly statistically significant for both overall expenditure on R&D and the percentage of employees engaged in R&D. A further similarity between the two countries is found in the positive impact of firm size on the probability of generating innovation.

Differences between the two countries were found with respect to a firm's location. In Israel, being located in the metropolitan area generally lowered the probability of generating innovation in traditional industries (the opposite was true for high-tech industries). It is possible that this statistically significant result is connected with the fact that most *kibbutz*-owned traditional firms which are located mostly in the peripheral area, have a greater tendency to innovate, than do firms in this group that are not owned by the *kibbutz* sector (see FRENKEL, 1997). In Germany, firms located in the intermediate zone increase their probability to innovate, albeit at a low level and then only when expenditure on R&D is in-house.

A further difference between the two countries related to the impact of a firm's age on the rate of innovation. In the traditional industries in Israel (though not in Germany), the age effect is positive and has statistical significance; in other words, the older the firm, the higher is the rate of innovation. The fact that most of the old innovative firms in this group of industries are owned by *kibbutzim* may serve as an additional explanatory factor. Most of these traditional firms were set up in the 1970s, when many *kibbutzim* began to undergo some structural change. Industrial jobs were created in order to reduce the surplus of workers in agriculture. From the mid-1980s, when *kibbutzim* began experiencing an economic crisis, they set fewer and fewer new firms in the traditional sector. The *kibbutz*-owned firms have indeed shown a high rate of innovation compared to the rest of the sample. When we introduced a new dummy variable for all *kibbutz*-owned firms, however, it was not found to be statistically significant. On the other hand, in neither country, was there any impact on the probability of generating innovation as a result of a firm's organizational structure.

The results of model (f) reinforce the conclusions regarding location impact on the rate of innovation of firms belonging to the group of traditional industries. The agglomeration index in Israel shows the negative impact of the metropolitan area. This negative effect is statistically significant, which is due specifically to the unique situation of Israel's northern periphery. In Germany, too, the rate of innovation of firms belonging to traditional industries was not found to be influenced by the agglomeration index. Nor was the positive effect of the intermediate zone of Freiburg on a firm's probability of generating innovation found to be related to the agglomeration index in this sub-region, which is similar to the index calculated for the peripheral area of Baden-Württemberg.

CONCLUSION

This paper has presented the results of a study that compared the innovative activity behaviour of industrial firms on a regional and national level in both Germany and Israel. The analysis utilized data gathered in the framework of a field survey conducted in each country and covering more than 400 firms in both the high-tech and traditional industries sector. Unlike many studies that did not use a shared database, we were presented with the opportunity to conduct a comparative study for a better examination of the similarities and dissimilarities between innovative behaviour in different locations in the two countries.

The results obtained from the study clearly attest to the contribution made by R&D activity to the generation of innovation in the two industrial group categories. In this connection, a similarity was found between Germany and Israel. The findings demonstrate the positive impact of the size of a firm on the propensity to

innovate. This result was found to be valid for both countries and for the two groups of industry examined. Age was found to have a negative effect on the propensity to innovate in the German high-tech industry. In Israel, on the other hand, the age of the firm was found to have a positive effect on the propensity to innovate in the traditional industries. This result is connected with both the structure of the metal and plastics industries and the age of these firms, which were established mostly by *kibbutzim* in the 1970s.

The effect of industrial sector on the percentage of innovative firms varies in accordance with location. In general, no significant differences in innovative ability were detected between the two countries. These results demonstrate the ability of a young, small country like Israel to reach a high level of innovation similar to that of a large, veteran country like Germany.

In both countries, innovation is more prevalent among high-tech firms than among traditional firms. The results of the logit model with respect to the percentage of innovative firms in the different sub-regions point to the prevalence of an inter-area variation in innovative capacities, especially in Israel. The high-tech firms located in the Haifa metropolitan area, with its high agglomeration index, enjoy a particularly high percentage of innovative firms. This significant outcome is apparently linked to the production milieu, with its well-developed infrastructure and other innovation-supporting economic activities. This infrastructure is reflected in the existence of academic institutions and research centres, a concentration of business services and a large pool of skilled labour, all of which help induce the generation of innovation. High-tech firms located in the metropolitan area engaged more in R&D and less in production activities. The latter are left to subsidiary plants located in the intermediate zone of central Galilee. The traditional industries in Israel demonstrate a 'reverse' spatial innovation pattern. In these industries, the percentage of innovative firms increases with the move to the peripheral area in spite of the fact that the index of agglomeration in this area is relatively low. This outcome is the result of both the unique characteristics of the Israeli periphery, where many *kibbutzim* are located, and the nature of its traditional industries, which apparently have less need for a production milieu.

In Baden, no significant locational impact on the propensity to innovate in high-tech firms was observed. Our findings corroborate the results obtained in other studies in Germany, where only a weak locational impact was found on a firm's innovation (MEYER-KRAHMER, 1985; BEISE and STAHL, 1999). Access to an innovation-supporting environment (e.g. the Universities of Karlsruhe and Freiburg, technical colleges, Fraunhofer institutes, Steinbeis transfer centres) is much less spatially limited in Germany than in Israel. The interregional variation in the percentage of innovative firms in Baden is not statistically significant. It is possible that the positive effect of the Freiburg intermediate zone on the propensity of traditional industries to innovate is rooted in historical causes and, as in Israel, is not affected by the agglomeration index.

One of the main research questions of the current study concerned the extent to which peripheral regions investigated reach a high level of development, particularly in the innovation game. Another related to the unique characteristics of the different regions included in the study, the answer to which might help decision makers in determining regional policy.

Examination of the attributes of the firms included in the study demonstrates a significant difference between the two countries in the distribution of firms by industrial sector and location. The share of the high-tech industries in the intermediate and peripheral areas in Germany is significantly larger than that in the central metropolitan area. In Israel, on the other hand, the share of high-tech firms in the metropolitan area and in the intermediate zone is much greater than in the peripheral area.

These findings shed new light on the role played by various types of regions in each of the two countries. Israel represents a unique situation, with its hermetically sealed border to neighbouring countries to the north. This situation adversely affects the peripheral region by reducing its attractiveness to highly innovative high-tech firms. On the other hand, Israeli rural settlements (the *kibbutzim*), which dominate the northern peripheral region, have succeeded in developing a relatively highly-innovative low-tech industry.

The strong impact of the metropolitan area in Israel on the propensity to innovate in high-tech firms diminishes towards the periphery. This is not the case in Baden, whose peripheral area is located next to one of Western Europe's major traffic junctions, near Basle, and in proximity to the open common border between Germany, Switzerland and France. Thus, the peripheral area of Baden benefits from the advantage presented by its location, as manifested by its higher rate of technological innovation.

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