The S. Neaman Institute for
Advanced Studies in Science and
Technology, Haifa, Israel

Fraunhofer Institute for
Systems and Innovation Research
Karlsruhe, Germany

Spatial Diffusion of Industrial Innovation and Regional Development

Final Report 1995-1998
Under Support of the German-Israel Foundation
Grant No. I-0278-031.04/93

December 1998

The S. Neaman Institute for Advanced Studies in Science and Technology, Haifa, Israel

Fraunhofer Institute for Systems and Innovation Research Karlsruhe, Germany

Spatial Diffusion of Industrial Innovation and Regional Development

Final Report 1995-1998
Under Support of the German-Israel Foundation
Grant No. I-0278-031.04/93

Principal Investigators:

Prof. Daniel Shefer
The S. Neaman Institute for Advanced Studied in Science and Technology,
Technion - Israel Institute of Technology, Haifa, Israel

Dr. Knut Koschatzky
Fraunhofer Institute for Systems and
Innovation Research, Karlsruhe, Germany

Research Associates:

Dr. Amnon Frenkel
The S. Neaman Institute for Advanced Studied in Science and Technology,
Technion - Israel Institute of Technology, Haifa, Israel

Dr. Guenter Walter
Fraunhofer Institute for Systems and
Innovation Research, Karlsruhe, Germany

December 1998

Table of Contents

Part I: Final report 1994-1998 Under Support of the German-Israel Foundation, Grant No. I-0278-031.04/93

ABSTRACT

Industrial innovation has long been recognized as a major agent in fostering regional economic growth. Thus the objective of the study was to identify the factors responsible for the spatial diffusion of industrial innovation and to examine the effect of innovation on regional development in Israel and in Germany.

The desire to develop peripheral regions exists in many countries throughout the world. In Israel, this desire has been translated into public policies whose aim is to develop the Northern Galilee and Southern Negev regions. In Germany, government programs in the form of investment allowances and the development of industry-related infrastructures were designed in order to promote the economic growth of lagging regions. We hypothesized that innovation is more prevalent in a group of fastest-growing industries (FGI) than in a group of slower-growing industries. Thus, the first task was to identify FGIs in the two countries – Germany and Israel. The second task was to collect data from a randomly selected sample of industrial plants. Altogether, more than 400 industrial plants belonging to the fastest-growing industrial branches (electronics, metals, and plastics) in both countries were included in the study. These industrial plants are located in three distinct geographical areas: center, intermediate, and peripheral. In the last stage, in order to test the hypotheses that the expenditure on R&D, the percentage of highly skilled labor, a firm's size and age as well as its location and local milieu affect the probability of the firm to innovate (regardless of the industrial branch to which it belongs), we employed simple statistical models, along with more complex, multivariate, discrete-choice models (Logit-type models).

In general, there exists a strong similarity in the frequency of industrial innovation in both countries: i.e., the rate of innovation in hi-tech firms is statistically and significantly higher than that found in "traditional" firms. On the other hand, the pattern and spatial variations in the rate of innovation in Israel is much more pronounced and visible than in Germany. In Israel, as one progresses from the center toward the periphery, the rate of innovation, among all firms, gradually and systematically diminishes.

A final workshop was held at the Interdisciplinary Institute for Applied Cultural Science at the University of Karlsruhe, Karlsruhe, Germany, on December, 17, 1998. Here the researchers presented the findings of the study, and a very interesting and penetrating discussion ensued. The study, methodology, results, and conclusions were all very well received. The workshop concluded with a call for a continuation of research in line with the current study.

1. Objectives of the Original Research Proposal

The primary goal of the research proposal between the S. Neaman Institute in Haifa, and the Fraunhofer Institute in Karlsruhe was to identify the spatial diffusion of industrial innovation and to examine its effect on regional growth and development in Israel. This enabled us to identify both the general and the country-specific aspects of spatial diffusion processes.

The findings increased our understanding of the most cost-effective policies for promoting innovation-oriented regional policies, thus fostering investments in industrial development and creating employment opportunities in lagging regions.

Our first major objective was to develop conditional probability Logit (and/or multinomial) models with which it would be possible to describe and explain the spatial diffusion of innovation processes of selected fast-growing industries.

The second major objective was to identify the relevant factors that promote the innovative capacities of regions and the intra- and inter-regional diffusion of innovation. We proposed a comparison of the factors that affect the spatial diffusion of innovation in Israel and Germany, thereby identifying effective regional-specific policies and instruments designed to reduce regional disparities and to strengthen the technological-industrial base of regions.

It was necessary to identify product or process innovation in the randomly selected sample of firms belonging to the FGIs that we proposed to investigate. In order to do so we proposed adopting the "Technometric Method" developed by Grupp and Associates (Grupp and Hohmeyer, 1986, 1988; Grupp 1990, 1991).

To investigate the impact of intra-firm and spatial variables on innovation processes, we suggested the use of multivariate Logit models. In these models, categorical variables are offered simultaneously as explanatory variables for product or process innovations. The sample divided into three types of locational characteristics: (1) core, (2) intermediate, and (3) peripheral regions. Attention also had to be given to the urban/rural size within which the firm is located.

2. Detailed Description of the Research Activities and Results

The major objective of this research project was to identify the spatial rate of industrial innovation and to examine its effect on regional development in Israel and Germany. This will lead to the identification of the general and country-specific aspects of spatial industrial innovation processes.

The desire to develop peripheral regions exists in many countries throughout the world, particularly in those countries where a wide socio-economic gap exists between core and peripheral regions. These gaps often exacerbate spatial social and political unrest in the country. To foster the economic growth of peripheral regions, it is necessary to create employment opportunities that will attract the population to come and settle in these regions and convince it to remain.

This study represents an attempt to carry out a cross-country study concerning industrial innovation in space and its impact on regional growth and development.

We hypothesized that innovation is more prevalent in a group of fast-growing industries (FGI) than in a group of slower growing industries. Therefore the first task was to develop a methodology for identifying FGIs in Israel and Germany (see Appendix A: "Targeting Industries for Regional Development in Israel and in Germany - A Comparative Study" by Shefer et al.). The rates of production, employment, and export growth were used as indices for classifying manufacturing industries in the two countries. These primary indices were augmented by the rate of R&D activity, measured by the change in the percentage of employees engaged in R&D, the change in the total expenditures on R&D, and the intensity of R&D activity in each industry. Four major industrial branches were identified as FGIs in the two countries at the end of this stage. Two industrial branches – electrical and electronic equipment and miscellaneous – were classified in the group of high-tech industries while the other two fastest-growing industrial branches – rubber and plastic products and metal products – were classified in the group of more "traditional" industries.

By analyzing the regional distribution of plants belonging to the fast-growing industrial branches in Baden and in Northern Israel, we were able to obtain some insights into the location preferences of these firms (see Appendix B: "Fast-Growing Industries as a Target Group for Regional Policy – A Comparison Between German and Israeli Industrial Firms" by Koschatzky et al.). The results of the analysis might be of some relevance for reducing inter-regional imbalances in economic activity and for supporting lagging regions. According to location theory and the expected impact of agglomeration economies on the location choice of firms, fast-growing industrial

firms should favor metropolitan areas. In both of our samples, however, a clear center-periphery dichotomy is not evident. Although regional variations in firm age, size, highly skilled labor, and R&D input affect the three types of areas differentially, the differences in most cases are statistically insignificant. Nevertheless, the analyses made it clear that high R&D intensity is linked more to central areas than to peripheral areas. Plants spending less on R&D are more prevalent in the intermediate and peripheral areas. This distribution is more pronounced in Northern Israel than in Baden, where electronics is an important industrial branch although, admittedly, not so R&D intensive. Following the assumptions associated with the product life-cycle hypothesis, we tested the hypothesis that the spatial distribution of highly skilled labor and R&D-intensive production in a technology-intensity industrial branch favor a central location. Support for this hypothesis was found especially in the Israeli case. On the other hand, this finding should not lead to the conclusion that firms belonging to FGIs located outside the metropolitan areas are less innovative. There is empirical evidence that supports the hypothesis that firms that do not have access to large pools of skilled labor compensate for this deficiency by employing adjusted innovation strategies; e.g., by substituting capital for skilled labor.

Fast-growing industrial branches, in particular those that do not rely strongly on proximity to metropolitan areas in order to secure innovation inputs, can contribute significantly to employment and income growth in non-center regions. Nevertheless, proximity to the central region (as is the case of the intermediate zone in Israel), well-developed transportation and communication networks, the availability of industrial sites, and a large pool of qualified labor are supportive factors in fostering industrial decentralization processes. This kind of decentralization can be expected, especially in a system in which intermediate or peripheral areas possess endogenous development potential allowing them to prosper independently of the center region. In Baden, this is the case for both the intermediate and peripheral regions, which have a long tradition as industry and service location and in which vocational training and experience in handling small parts (e.g., watch-making industry in Schwarzwald-Baar-Heuberg) have supported industrial development and diversification. In Northern Israel, it is the peripheral area that originally served as an agricultural settlement region for the kibbutzim. These collectives are not only engaged in agricultural production; they have also diversified their economic activities, particularly entering the manufacturing of plastic products. The already developed economic base of the periphery in Baden and in Israel made decentralization possible, especially for those fast-growing industrial branches that can compensate for a less-innovative regional environment by drawing on an educated workforce that is present in this type of region.

There are two important conclusions that can be drawn from the empirical analysis of Baden and Northern Israel:

l) Fast industrial growth is also possible in peripheral regions, especially in industrial plants and branches that do not rely heavily on links and proximity to urban knowledge bases.

2) Decentralization of fast-growing industries to intermediate and peripheral areas will be enhanced by an existing endogenous production system in these regions. Decentralization not only supports learning and knowledge creation within the regional labor force, but it also generates conditions for promoting the development of production facilities in the peripheral and intermediate regions.

The experiences of both Baden and Israel's Northern region lead to the conclusion that above-average industrial growth in peripheral regions is possible, provided that endogenous economic potentials exist in the area. This precondition might not prevail in all peripheral regions, but it may in regions where infrastructure and human capital are well developed.

From the results obtained in the empirical analyses (see Appendix C: "Regional Concentration and Dynamics of Fast-Growing Industries in Baden-Württemberg and Israel", by Koschatzky, et al.), it can be concluded that FGIs behave as we hypothesized; that is, they are mainly located in the center (metropolitan areas.)

Nevertheless regional concentration was seen to have lessened between the late 1980's and 1990's. This process can be interpreted as a reduction in regional disparities with respect to FGI employment in both countries. A look at employment growth in the different types of region, shows that growth resources have been utilized outside metropolitan areas. Although it was mainly the intermediate regions in Baden-Wurttemberg that profited from the economic performance of FGIs, no clear conclusion can be drawn for Israel because of the relatively gross spatial delimitation used by the Israeli Central Bureau of Statistics. It is our conclusion that in Israel, not only peripheral regions, but intermediate areas (classified partially as central and partially as peripheral areas) as well, showed a high increase in employment.

The lower variation coefficients for Baden-Wurttemberg might suggest that a regional policy aimed at reducing spatial imbalance between regions is more effective in Baden-Wurttemberg than in Israel. In both case studies, an analysis of the data leads to the conclusion that changes in the location behavior and spatial distribution of FGIs have occurred between the late 1980's and early 1990s. Still, the majority of firms

(measured by employment) are located in central regions. Other regions, however, also have location advantages that are able to attract innovative, knowledge-intensive industrial enterprises. This can be interpreted as an indication that knowledge spillovers can be realized outside metropolitan areas.

An examination of the attributes of the firms included in the study points to significant differences between the two countries in the distribution of firms by industrial branches and location. The share of hi-tech industries in the intermediate and peripheral areas in Germany is significantly larger than its proportion in the central metropolitan area. In Israel, on the other hand, the share of hi-tech firms in the Haifa metropolitan area, and in the intermediate zone, is much greater than in the peripheral area (see Appendix D: "Industrial Pattern Characteristics, Production Milieu, and Regional Innovation: A Comparison Between Israeli and German Plants" by Frenkel et al.).

The results derived from the study clearly attest to the contribution made by R&D activity to generating innovation in the two industrial group categories. In this connection, a similarity was found between Germany and Israel. The study's findings demonstrate the positive impact of the size of the firm on the propensity to innovate. This result was found to be valid for both countries and for the two industrial branches examined (metals and plastics). Age was found to have a negative effect on the propensity to innovate in the German hi-tech industry. In Israel, on the other hand, it was found that the age of the firm has a positive effect on the propensity to innovate in "traditional" industries. This result is connected to the structure of the metals and plastics industries in Israel and to the age distribution of firms, which were established primarily in the 1970s, most of them by the kibbutzim.

The effect of industrial branches on the rate of innovation varies in accordance with location. In general, no significant differences between the innovative ability of the two countries were detected. In both countries, innovation is more prevalent among the hi-tech firms than among the "traditional" firms. The results of the Logit model with respect to the rate of innovation frequency in the different sub-regions point to the prevalence of an inter-area variation in innovative activities, especially in Israel. The hi-tech firms located in the Haifa Metropolitan area, with its high agglomeration index, enjoy a particularly high rate of innovation. This significant result is apparently linked to the production milieu, in which well-developed infrastructure as well as economic activities supporting innovation exist. The infrastructure is reflected in the existence of academic institutions and research centers, a concentration of business services, and a large pool of skilled labor, all of which help induce innovation.

Hi-tech firms located in the metropolitan area engage more in R&D and less in production activities. The latter activities are left to the subsidiary plants located in the intermediate zone of the Central Galilee. The traditional industries in Israel demonstrate a "reverse" spatial innovation pattern. In these industries, the rate of innovation increases with the move to the peripheral area, in spite of the fact that its index of agglomeration 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 the traditional industries, which have less need for a production milieu (as reflected in the high agglomeration index value).

In Germany, no significant location impact on the rate of innovation of hi-tech firms was observed. The inter-regional variation in the rate of innovation in the state of Baden-Württemberg is not statistically significant. It is possible that the positive effect of the intermediate zone of Freiburg on the rate of innovation in traditional industries is rooted in historical causes and, as in Israel, is not affected by the agglomeration index. As noted above, the strong and marked impact of the metropolitan area in Israel on the rate of innovation in hi-tech firms, compared to the decrease in this rate when moving out toward the periphery, does not exist in Baden-Württemberg. The reason may be associated with the differing nature of the peripheral areas in the two countries. In Israel, the northern peripheral area is hermetically sealed to neighboring countries, whereas the peripheral area of Baden-Württemberg is located next to one of Western Europe's major traffic junctions, near Basle, and in proximity to the open border shared by Germany, Switzerland, and France. This is most definitely not a sealed peripheral area, and it can apparently benefit from the advantage offered by its location. Therefore, the peripheral area in Germany, which is not similar in character to Israel's peripheral area, could enjoy a higher rate of technological innovation.

3. Cooperation Between the Research Teams in Germany and Israel

Cooperation among the Israeli and German researchers was close and effective. It found expression in the following ways:

Publications

We anticipate that 4-5 publication will result from our collaboration. Responsibility for authorship, revision, and submission to journals were all shared. Articles have been submitted to the leading journals in the area of regional science, among them Regional Studies, Planning and Environment C, Policy Research, and International Planning Studies.

Presentation of papers at international conferences

Prof. D. Shefer and Dr. A. Frenkel presented papers at two international conferences as follows:

1. 38th European Regional Science Association, Vienna, Austria -- "Industrial Pattern Characteristics, Production Milieu, and Regional Innovation: A Comparison Between Israeli and German Plants."

2. Western Regional Science Association, Ojai Valley, California, 21-24 February 1999 -- "Targeting Industries for Regional Development in Israel and in Germany - A Comparative Study."

Data collection

The data collected in Germany and Israel on the structure of regional innovation concerned industrial firms in a selected number of fast-growing industrial branches. These included the three following major branches of industry: electronics (including optics and precise instruments), plastics, and metal products.

Identification of the fast-growing industries was based on an analysis of the rate of growth in output, employment, and exports in each of the industrial branches.

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

In Israel, personal interviews were held with senior managers in each of the 211 firms included in the sample. This sample comprised approximately 72% of the firms associated with the three industrial branches in the surveyed region,. In Germany, questionnaires were mailed to approximately 2,800 plants located in the research region - the federal state of Baden-Württemberg. A total of 482 plants returned the questionnaire with the requested information; of these, 220 came from the three fast-growing industrial branches that had been selected.

Formal meetings

List of mutual visits:

Haifa, 20-29 May 1995
Dr. K. Koschatzky and Dr. W. Gunther, working meeting
with Prof. D. Shefer and Dr. A. Frenkel.

Karlsruhe, 23-25 October 1995
Prof. D. Shefer and Dr. A. Frenkel, working meeting
with Dr. K. Koschatzky and Dr. W. Gunther.

Haifa, 17-21 April 1996
Dr. K. Koschatzky and Dr. W. Gunther, working meeting
with Prof. D. Shefer and Dr. A. Frenkel.

Karlsruhe, 6-10 October 1996
Prof. D. Shefer and Dr. A. Frenkel, working meeting
with Dr. K. Koschatzky and Dr. W. Gunther.

Haifa, 28 May – 1 June 1997
Dr. W. Gunther, working meeting with Prof. D. Shefer and Dr. A. Frenkel.

Rome, 26-29 August 1997
Prof. D. Shefer and Dr. A. Frenkel, working meeting with Dr. K. Koschatzky
during the 37th European Regional Science Association.

Vienna, 28 August – 1 September 1998
Prof. D. Shefer and Dr. A. Frenkel, working meeting with Dr. K. Koschatzky
during The 38th European Regional Science Association.

Karlsruhe, 16-19 December 1998
Prof. D. Shefer and Dr. A. Frenkel, working meeting
with Dr. K. Koschatzky and Dr. W. Gunther.

Workshops

Two workshops were held in the course of our study. The first one took place in Tefen – an industrial park in Northern Israel, on Thursday, May 29, 1997. At that workshop preliminary findings were presented, and a very fruitful discussion ensued.

The second workshop was conducted at the Inter-disciplinary Institute for Applied Cultural Science (IKA) at the University of Karlruhe, on December 17, 1998. Our final results were presented as were the methodologies used in our research project. Several invited guests came from East European countries – Hungary, Croatia, and Bulgaria - as did participants from the U.S.A and Scotland. In the course of the presentation, the relevancy of our findings to other places was discussed.

Enclosed are the programs of the two workshops.

The S. Neaman Institute for Advanced Studies in Science and Technology

MIT Enterprise Forum of Israel

G.I.F. - German-Israel Foundation

Technion - Israel Institute of Technology
Faculty of Industrial Engineering and Management

Symposium on

Innovation: Technology Assessment, Forecasting, Strategy, and Regional Policy

Thursday, May 29, 1997

at Iskar Ltd., Tefen, Galilee

Program

08.00	Meet at the S. Neaman Institute, Technion, Haifa Transportation by bus to Iskar Ltd., Tefen
09.15	Registration, Coffee, Welcome
09.30-10.15	**Technology Assessment** "Managing Incremental and Radical Innovation - A Decision-Support Model for Optimizing R&D Investment, with Applications to Science Based Products" Asaf Ben-Arieh, Hariolf Grupp, Shlomo Maital
10.15-11.00	**Technology Forecasting** "Technology Assessment Through Foresight: Synergies Between Two Strands of Research" Hariolf Grupp
11.00-11.30	Tour of Iskar Factory
11.30-12.15	**Technology Strategy** "Technology Strategy among Israeli Start-ups: A Strategic Reference-Point Model" Avi Feigenbaum
12.15-13.00	Lunch
13.00-14.15	Guided Tour of the Tefen Area and Kfar Vradim

14.15-15.00 **Regional Policy #1**
"Regional Innovation Profiles of Firms in Fast-Growing Industries: A German-Israel Comparison"
Amnon Frenkel and Daniel Shefer

15.00-15.45 **Regional Policy #2**
"Emergence and Development of Regional Technology Policy in Germany: The Technological Region of Karlsruhe as an Example"
Guenter H. Walter

15.45-16.00 Wrap-up

16.00-17.00 Return by bus to the S. Neaman Institute

Fraunhofer Institute for Systems and Innovation Research (ISI)
Karlsruhe, Germany

University of Karlsruhe
Interdisciplinary Institute for Applied Cultural Science (IAK)
Karlsruhe, Germany

The Samuel Neaman Institute for Advanced Studies
in Science and Technology (SNI), Haifa, Israel

Workshop

Fastest-Growing Industries:
A Target Group for Innovative Regional Development
and Regional Technology Policy?

Thursday, December 17, 1998
at the Interdisciplinary Institute for Applied Cultural Science

Program

09.00 Welcome and Introduction
Caroline Robertson-Wensauer (IAK), and Hariolf Grupp (ISI)
Discussion

09.20 Targeting Industries for Regional Development in Israel and Germany –
A Comparative Study
Daniel Shefer (SNI) and Amnon Frenkel (SNI)
Discussion

10.00 Regional Concentration and the Dynamics of Fastest-Growing Industries in
Baden-Württemberg and Israel
Knut Koschatzky (ISI)
Discussion

10.45 Coffee Break

11.00 Firm Characteristics, Location, and Regional Innovation: A Comparison
between Israel and German Industrial Firms
Amnon Frenkel (SNI) and Daniel Shefer (SNI)
Discussion

11.45 Amelioration of Industrial Structures - An Appropriate Approach for Croatia
Mira Lenardic, Ministry of Development and Reconstruction (MODR),
Zagreb, Croatia
Discussion

12.30 Lunch

14.00 Fastest-Growing Industries and their Role in Regional and National Technology Policy
Günter H. Walter (ISI)
Discussion

14.45 Regional Culture - A Basis for a Regional Technology?
Caroline Robertson-Wensauer (IAK)
Discussion

15.30 Coffee Break

16.00 Fastest-Growing Industries: A Target Group for Innovative Regional Development and Regional Technology Policy?
Amnon Frenkel (SNI), Daniel Shefer (SNI), Knut Koschatzky (ISI), Hariolf Grupp (ISI), Günter H. Walter (ISI), Caroline Robertson-Wensauer (IAK) and Mira Lenardic (MODR)
Panel Discussion

16.45 Concluding Remarks

4. Evaluation of Research Achievements in Relation to the Aims of the Original Research Proposal

On the whole, our project achieved most of the objectives set forth in our initial proposal. Members of the two research teams collaborated effectively and efficiently.

Furthermore, we were fortunate to be able to construct a database from a relatively large sample of firms. By drawing on resources from other related research projects (in Israel and in Germany), we were able to expand our sample size to over 400 firms.

We expanded our empirical analysis by including a temporal macro-analysis of industrial change in Israel and Germany. This was necessary in order to test our initial hypothesis concerning the high rate of industrial innovation in fastest-growing industrial branches. The effect of geographical concentration - agglomeration and localization of various industrial branches - on the rate of innovation was also thoroughly investigated.

In the multi variate discrete-choice models, we introduced alternative measures for the index of agglomeration. This idea proved to be very productive for identifying the relative importance of agglomeration economies on the rate of innovation for each of the selected industrial branches.

One proposed objective, however, was abandoned after the first year. This was the employment of the Technometric technique in our regional analysis. The Technometric technique was originally developed as a technological indicator for cross-country analysis. In recent years, however, the technique has also been successfully applied to the firm level. It was used in the analysis of the relationship between the modal level of technological excellence across firms and the level of complexity characterizing a product's technology. Nevertheless, Technometric is more a national than a regional technique, however regional variations – even among firms – have up to now been excluded from the analysis.

Our data furtheremore, were gathered from a large number of multi-product firms; that is, firms that are engaged in producing more than a single product. The application of the Technometric technique, however, requires data concerning homogeneous products from each industrial branch and from each designated location. Unfortunately our data did not allow us to stratify the sample to such a degree and still to retain a sufficiently large number of observations for a meaningful analysis.

5. List of Papers and Publications

1. Shefer, D., Frenkel, A., Koschatzky, K., Walter, G.H. (1998). "Targeting Industries for Regional Development in Israel and in Germany - A Comparative Study." Submitted to ***Environment and Planning B.***

2. Koschatzky, K., Walter, G.H., Frenkel, A., Shefer, D. (1998). "Fast Growing Industries as a Target Group for Regional Policy – A Comparison Between German and Israeli Industrial Firms." Submitted to ***Policy Research***.

3. Koschatzky, K., Frenkel, A., Walter, G.H., Shefer, D. (1998). "Regional Concentration and Dynamics of Fast Growing Industries in Baden-Württemberg and Israel." Submitted to ***International Planning Study***.

4. Frenkel, A., Shefer, D., Koschatzky, K., Walter, G.H. (1998). "Industrial Pattern Characteristics, Production Milieu, and Regional Innovation: A Comparison Between Israeli and German Plants." Submitted to ***Regional Study.***

Part II – Appendixes: Copies of Scientific Papers

Appendix A - Targeting Industries for Regional Development in Israel and in Germany - A Comparative Study.

Appendix B - Fast-Growing Industries as a Target Group for Regional Policy – A Comparison Between German and Israeli Industrial Firms.

Appendix C - Regional Concentration and the Dynamics of Fast-Growing Industries in Baden-Württemberg and Israel.

Appendix D - Industrial Pattern Characteristics, Production Milieu, and Regional Innovation: A Comparison Between Israeli and German Plants.

Appendix A

Targeting Industries for Regional Development in Israel and in Germany - A Comparative Study

Daniel, Shefer[**], **Amnon, Frenkel**[**], **Knut Koschatzky**[*], **Guenter, H. Walter**[*]

Submitted to *Environment and Planning B*

** S. Neaman Institute for Advanced Studies in Science and Technology, Technion - Israel Institute of Technology, Haifa, Israel.

* Fraunhofer Institute for Systems and Innovation Research, Karlsruhe, Germany.

ABSTRACT

The present paper reports on a methodology developed and used in the process of identifying the fastest-growing group of industrial branches. We hypothesized that rate of innovation in the group of fastest-growing industries is by far greater than in the group of slower-growing industries. Since economic growth is driven to a large extent by technological progress or innovation, it is essential for effective public policy to identify the group of fastest-growing industries. The findings corroborate the hypothesis that firm belonging to the group of Hi-tech industries have a greater probability of engaging in innovation. This is a significant finding that could assist in designing effective public policies aimed at inducing regional innovation.

Introduction

This paper reports the results of the first stage of a larger study concerned with the spatial diffusion of innovation in selected industries and its effect on regional growth. The assumption is that the engine for economic growth rests on technological change and innovation (see: Schumpeter, 1934; Dosi, 1988; Freeman et al., 1982; Nelson and Winter, 1982; Bertuglia et al., 1995, 1997; Frenkel and Shefer, 1997).

The prevalence of innovation activities in any group of fastest-growing industries is assumed to be greater by far than in a group of slower-growing industries. The major objective of the current study is to develop a methodology with which it will be possible to identify the former group of industries. Since economic growth is driven to a large extent by technological progress, it is essential for effective public policy to identify the fastest-growing industries (Schmookler, 1966; Grossman and Helpman, 1991b; Segerstrom, 1991; Barro and X sala-i-Martin, 1995).

In recent years, industrial innovation has been recognized as a major resource for fostering economic growth. The resurrection of interest in economic growth models, prompted by the seminal work of Romer (1986) and Lucas (1988), brought to the fore the importance of endogenous technological progress. This new development was contrary to the neoclassical model of growth theory espoused by Solow (1956 and 1970), in which technological progress was assumed to be exogenous. Furthermore, Solow focused his attention primarily on the process of capital accumulation and its relationship to a steady state, not on the process of generating technological progress. Thus, under the assumptions of constant returns to scale and fixed technology, as capital per worker rises, diminishing marginal productivity of capital sets-in, and capital investment will be made at a rate sufficient only to replace depreciation and provide capital for new workers.

The restrictive assumptions embedded in the neoclassical model - exogenous technology, constant returns to scale, and diminishing marginal productivity of capital in a perfect competition situation - do not provide good explanations for the observed process of continuous growth in per capita income and, thus, standard of living. The endogenous economic growth models that emerged in the 1980s suggest that firms may invest in new technology through expenditure on research and development if they perceive an opportunity to make a profit (Stokey, 1995). Thus technological progress, could explain the persistent growth in income and consequently in income per capita or standard of living (Romer, 1994; Grossman and Helpman, 1991a; 1991b, 1994; Pack, 1994).

Industries that are heavily engaged in technological innovation activities usually 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 share, profitability and employment growth.

Open economies can take advantage of an expanded market and, through increasing returns to scale, enjoy greater production efficiency and a higher rate of economic growth. Greater production efficiency enables industries to expand their domestic market share through import substitution and increases in local consumption and, at the same time, to penetrate new foreign markets and increase their export share (Grossman and Helpman, 1990a, 1990b; Porter, 1990; Noponen et al., 1993; Krugman, 1979, 1990, 1991, 1995).

There is ample evidence supporting the hypothesis that innovation activities are more prevalent among fastest-growing industries. Thus, it would be promising to investigate the phenomenon of innovation activities among firms belonging to this specific group - industries that most often provide the engine of economic growth (Suarez-Villa and Walrod, 1997).

The ability of a firm to innovate is contingent upon two major groups of variables. The first group is internal, and the second external to the firm (Davelaar and Nijkamp, 1989; Harrison et al., 1996; Shefer and Frenkel, 1998; Tödtling, 1990; Koschatzky, 1997).

The following variables can be identified in the first group: size, age, ownership type, location, type of industry to which the firm belongs and the extent of R & D activities taking place in the firm. R & D activities can be measured either by the number of employees engaged in that activity or by the total expenditure allocated to it. The second group of variables, those that are external to the firm, creates *the local innovation milieu* or the innovative environment conducive to innovation. These variables include the degree of cooperation and collaboration among firms and the degree of economies of localization and agglomeration as depicted by the spatial concentration of either similar (competitive) or complementary firms (Shefer and Frenkel, 1998).

This 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 (Dieperink and Nijkamp, 1988, 1990; Camagni, 1991, 1995; Kleinknecht and Poot, 1992; Shefer and Frenkel, 1998; Frenkel, et al., 1998).

We hypothesized that innovation is more prevalent in the fastest-growing industries than in the slower-growing industries. Furthermore, the rate of innovation in advanced high-technology industries far exceeds that in the more traditional industries.

In the present paper, we present a methodology, that was developed and utilized in the process of identifying the group of fast-growing industries in two countries - Israel and Germany. From among this group, we intend to randomly select a sample of firms from which to collect the data to be used in our comparative analysis of the rate of innovation patterns in firms.

Methodology for the Classification of Industries

We postulate that the innovation potential and innovativeness of the fastest-growing industries is far greater than those of slower-growing industries. Thus the first task was to identify the group of fastest-growing industries in the two countries - Germany and Israel.

We first classified all industrial branches according to rate of growth with respect to output and employment. These growth rates indicate the vitality of the industry and its competitive edge. Their influence on the economy, therefore, is assumed to be greater than that of sluggish industries.

The choice of a period in which to examine growth rates is of great importance. A great deal of fluctuation exists in the growth rates of industries over a long period of time. These fluctuations derive from changes that take place in local, national and international economic circumstances. The conclusion is that it would be better to examine the growth rate in the most recent period for which data are available. Thus the period that was determined to be relevant for our analysis were the five years between 1987 and 1992. An examination of the growth rates of industries during that period was based on the following four indices:

- Change in production output;
- Change in the number of employees;
- Share of export in total turnover;
- Change in export share.

The first two indices are concerned with the relative position of each industry independent of its export performance. These indices point out the growth trend of each industry as indicated by the rate of growth in both indices, the change in the

number of employees, and the change in production output. The two indices are also used in order to identify industries that reduced their number of employees, but at the same time increased their output. Concomitantly, they allow us to identify industries that show a noticeable increase in the number of employees, but no rise in production output.

The next two indices deal with the relative importance of exports particularly to the economy of a small country like Israel, in which the size of the local market is relatively small. We postulated that industries having a great export potential stand a better chance growing compared to industries that rely mainly on local markets. This potential growth is expressed by the export share in total revenues and the growth of that share during the time period selected for study.

In addition to those four indices, we also analyzed the financial and labor resources devoted to research and development (R&D) by each industrial branch. R&D activity is a catalyst for innovative industrial activities, and ultimately it is responsible for the growth in productivity and turnover. The share of labor engaged in R&D is a dominant factor here.

In countries with a high standard of living, the competitive advantages of a domestic industry lie mainly in its ability to generate industrial innovations. Innovative enterprises are in a position to solve techno-economic problems, close the gaps in the supply of existing demand and meet new demand as it arises. They can also create new needs, open up new sales potentials and find new applications for old products. Thus there is usually a relationship between the total revenue (turnover) of an enterprise and its expenditure on R&D. The higher the rate of expenditures on R&D, the greater tends to be the growth in production outputs.

In order to measure the extent of R&D activities, the ratio of expenditures on R&D activity to total turnover (R&D intensity) was used[1]. Industries in which R&D expenditure exceeds 3.5% of total turnover were classified as technology-intensive, or high-tech, and thus were assumed to have a greater potential for innovation (Gehrke and Grupp, 1994).

Three additional indices considered here are as follows:

- Change in the number of employees engaged in R&D;

---

[1] One should bear in mind that this indicator gives only a rough estimate of R&D-intensity, since it does not take into consideration market penetration (i.e., the amount of goods and services purchased externally). Nevertheless, it is still commonly used in statistics and in R&D analyses.

- Change in the total expenditures on R&D;
- R&D intensity (percentage expenditure on R&D of total turnover).

Data Base and Procedures

The data sources for Israel were based on reports published by the Israel Central Bureau of Statistics and by the Center for Economic Planning - the latter a unit within the Ministry of Industry and Commerce.

The data sources for Germany were based on reports of the Statistics Bundesamt (Federal Statistics Office) and Stiftertverband der deutschen Wissenschaft (Donor Association for German Science). Because of the variation in and heterogeneous nature of data sources, assignment to product groups is not always a straightforward procedure. If, however, the purpose of the analysis is kept in mind, it can generally be stated that this problem does not result in any major errors.

In order to make the data for Israel and Germany compatible, the German industrial branch code (SYPRO classification) was matched by a detailed branch analysis with the Standard Industrial Classification used in Israel, except for the R&D statistics in Germany, which is available only at a relatively high level of aggregation (see Table 5). The results obtained in this procedure are presented in Table 1[2] .

In Germany, the data on railroad production is included in the metal products industry; in comparison with Israel, this classification might be slightly biased, but since railroad production is relatively small, it contributes only a small percentage to the production output of the metal products industry or even to the transport equipment sector. Thus this minor difference is tolerable.

---

[2] Unless otherwise noted, the period covered by the analysis is 1987-1992.

Table 1: Comparison of Major Israeli and German Industrial Branches

code	Israel	sypro code	Germany
10	Mining and quarrying	21	Mining
		25	Quarrying
11, 12	Food, beverages and tobacco	68	Food
		69	Tobacco
13	Textile	63	Textile
14	Clothing and made-up textile	64	Wearing apparel
15	Leather and its products	61	Leather
		62	Leather products
16	Wood and its products	53	Sawmills and timber processing
		54	Wood processing
17	Paper and its products	55	Pulp and paper processing
		56	Paper products
18	Printing and publishing	57	Printing
19	Rubber and plastic products	58	Plastic products
		59	Rubber products
20	Chemical and oil products	22	Oil refining
		40	Chemical products
21	Non-metallic mineral products	51	Ceramic products
		52	Glass products
22	Basic metal	27	Iron and steel products
		28	Non-ferrous metals
		30xx	Drawing plants, cold rolling mills
23	Metal products	29	Foundries
		30yy	Steel forming, surface coating, hardening
		31	Structural metal products (incl. railroads)
		38	Tools, finished metal products
24	Machinery	32	Mechanical engineering
25	Electrical and electronic	36	Electrical engineering
		50	Office machinery, data proc. equipment
26	Transport equipment, aircraft and spacecraft	33	Road vehicles
		34	Shipbuilding
		35	Aircraft and spacecraft
28	Miscellaneous	24	Fissile and fertile material
		37	Precision and optical instruments
		39	Musical instruments, toys, etc.

Classification According to Production, Employment and Export Indices

The first analysis is based on comparative growth rates in employment and production output in each industrial branch. The increase in production outputs was calculated as the change in the industrial production index for each branch. Rates of growth were calculated for 17 major industrial branches, according to the matching classification division at a two-digit Standard Industrial Classification (SIC) level.

The results depicted in Table 2 reveal that during the period from 1987-1992, the average rate of growth in production output in all the industrial manufacturing branches was 17% in Israel and almost the same in Germany (16.9%). The growth in the number of employees was 7.6% in Israel and only 4.0% in Germany. A comparison of each industrial branch to the average for all manufacturing industries formed the basis for distinguishing the fastest-growing industries from the slower-growing ones.

The results show that there are a number of fastest-growing industrial branches that were affected primarily by the unique circumstances prevalent at the time the data were collected in both Israel and Germany.

The advent of unexpected events in late 1989 and early 1990 made a significant mark on the entire world, but were most pronounced in their effect on Germany and Israel. The socio-economic shock caused by the almost sudden reunification of Germany and the absorption, in a relative short period of time, of a flux of hundreds of thousands of new immigrants from the former Soviet Union by Israel, vibrated throughout the entire social and economic fabric of both countries. The rapid expansion in local demand for consumer goods and services, particularly food and beverage, construction material, and other durable and non-durable goods, resulted in a significant growth in the outputs of several related industries. Thus, it was our intention to differentiate between export-based fast-growing industries and local-demand-led industries. The former, we maintain, indicates competitive advantage and thus could be long lasting, whereas the latter represents a mere response to a one-time sudden change in local demand.

In Israel, the effect was profound especially in the areas of non-metallic mineral products and wood and its products. In these two industrial branches, the growth rate was very high (five to seven times the average increase in employment and two to four times the average growth in production output).

The tremendous growth rates in both of these industrial branches were due to the rapid increase in local demand for consumer products. The most profound effect was detected in the construction industry because of the new demand created for housing.

Consequently, these two industrial branches bias the average growth rate of the entire manufacturing industry in a way that skewed the "natural rate of increase" of manufacturing industries as a whole. Table 2 depicts the data on growth rates, excluding the above-mentioned two industrial branches. The table shows that by excluding these two industrial branches, the average rate of growth in industrial production in Israel was only 14%, and the increase in the number of employed workers was only 5.5%.

Table 2: Changes in Industrial Production and Number of Employees, 1987-1992 by Industrial Branch

Code	Major Industrial Branch	Increase in Industrial Production (%) 1987-92		Increase in the Number of Employees (%) 1987-92		% of Employees			
						Israel		Germany	
		Isrl.	Ger.	Isrl.	Ger.	1987	1992	1987	1992
10	Mining and quarrying	14.3	8.9	-14.6	-10.8	1.2	1.2	5.0	4.3
11,12	Food beverages and tobacco	2.6	24.6	-4.0	14.7	16.6	14.8	6.3	6.9
13	Textile	11.6	-7.7	-21.5	-14.4	4.9	3.6	3.1	2.6
14	Clothing and made-up textile	3.5	-19.2	9.3	-16.9	11.0	11.2	2.5	2.0
15	Leather and its products	13.8	-22.4	11.0	-25.4	1.3	1.4	0.8	0.6
16	Wood and its products	29.5	30.6	54.3	16.3	4.3	5.3	3.2	3.6
17	Paper and its products	11.9	21.2	-7.2	12.0	2.3	2.0	2.1	2.3
18	Printing and publishing	8.8	23.3	29.3	15.2	4.6	5.5	2.3	2.6
19	Rubber and plastic products	23.1	27.3	20.3	21.2	4.4	5.0	4.6	5.4
20	Chemical and oil products	29.7	15.0	0.9	1.5	6.0	5.6	8.5	8.3
21	Non-metallic mineral products	72.7	14.0	40.3	3.6	2.8	3.7	1.6	1.6
22	Basic metal	44.1	11.1	-11.6	-8.4	2.2	1.8	4.4	3.9
23	Metal products	17.8	23.1	13.2	11.4	13.1	13.8	9.9	10.7
24	Machinery	3.6	11.1	0.4	5.5	3.1	2.9	14.0	14.2
25	Electrical and electronic equipment	16.8	19.3	7.1	2.8	13.9	13.8	15.0	14.9
26	Transport equipment	0.8	15.1	8.5	3.0	5.5	5.5	13.6	13.5
28	Miscellaneous	37.7	18.7	17.4	0.5	2.8	3.1	2.9	2.8
	Total	17.0	16.9	7.6	4.0	100.0	100.0	100.0	100.0
	Total adjusted[1]	14.0	15.4	5.5	2.2			86.0	84.6

1. The data for Israel, do not include two industrial branches: non-metallic mineral products, and wood and its products. In Germany, the data do not include 4 industrial branches: food, wood, paper and printing (for explanation, see the text).

In Germany, the consequences of the reunification, particularly from 1989-1992, can be listed as follows:

- A need to close the gap between the west and the east with respect to the consumption of durable and consumer goods;
- An increase in the demand for housing, thus affecting the construction industry;
- A production boom in wood and its products;
- The urge to compensate for decades of repressed information needs (print media).

In the two periods, 1987-1989 and 1989-1992, the rate of production of food, beverage and tobacco had increased in Germany by 5.8% and 23.2%, respectively; and for wood and its products, by 12.2% and 17.3%, respectively. These growth rates would thus appear to be caused by the first shock of the reunification. The large amount of cash transferred from west to the east provides a good explanation for the sudden, rapid, unprecedented growth in production outputs in these industrial branches during the latter period. Therefore the following industrial branches were excluded from our analysis: food, beverages and tobacco, wood, paper and their products and printing and publishing. After excluding these industrial branches, the total growth in production outputs, as shown in Table 2, had amounted to only 15.4%, and the total increase in employment only 2.2% in Germany.

Figures 1a and 1b depict, in Israel and Germany respectively, the distribution of industrial branches on a two-dimensional diagram. The X axis delineates the change in the number of employees during the period from 1987-1992, and the Y-axis the change in production outputs. The results point to the same three industrial branches in the two countries with a high rate of growth in both production outputs and in employment. These industrial branches, labeled the fastest-growing industrial branches, are as follows: rubber and plastic products (19); metal products (23); and electrical and electronic equipment (25). In Israel one finds another fast-growing industrial branch - miscellaneous (28), consisting of precision, optical and photographic instruments. In Germany, the miscellaneous industry grew above the average only in production.

Figure 1a: Distribution of Industrial Branches in Israel According to their Growth Rate in Production and Employment, 1987-1992 (Excluding Wood and Non-metallic Mineral)

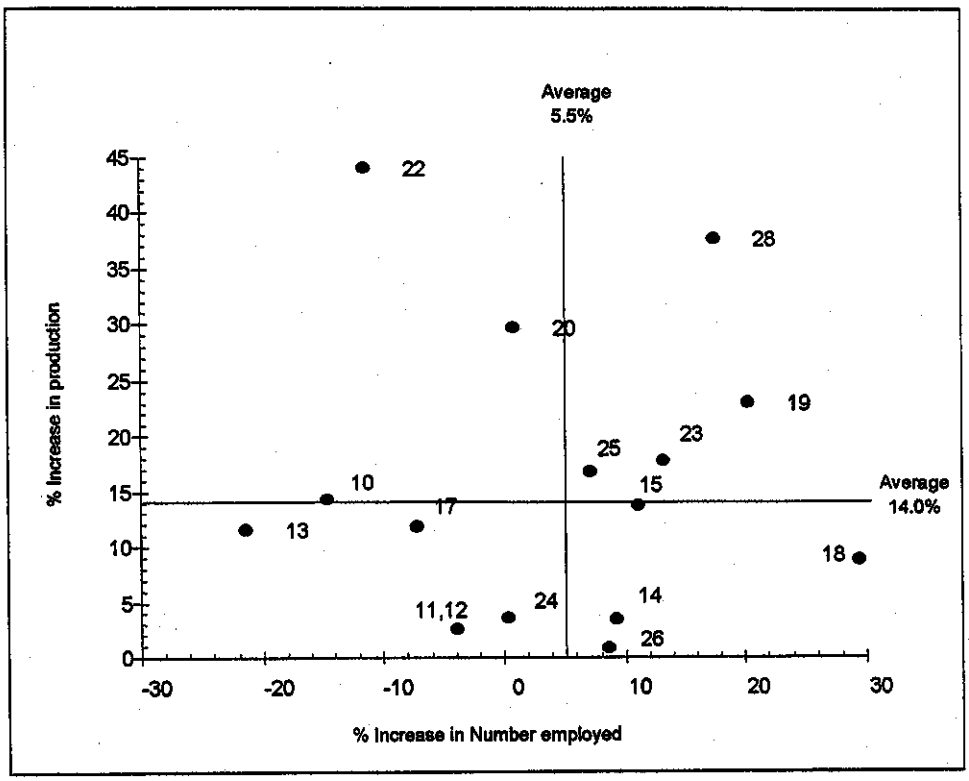
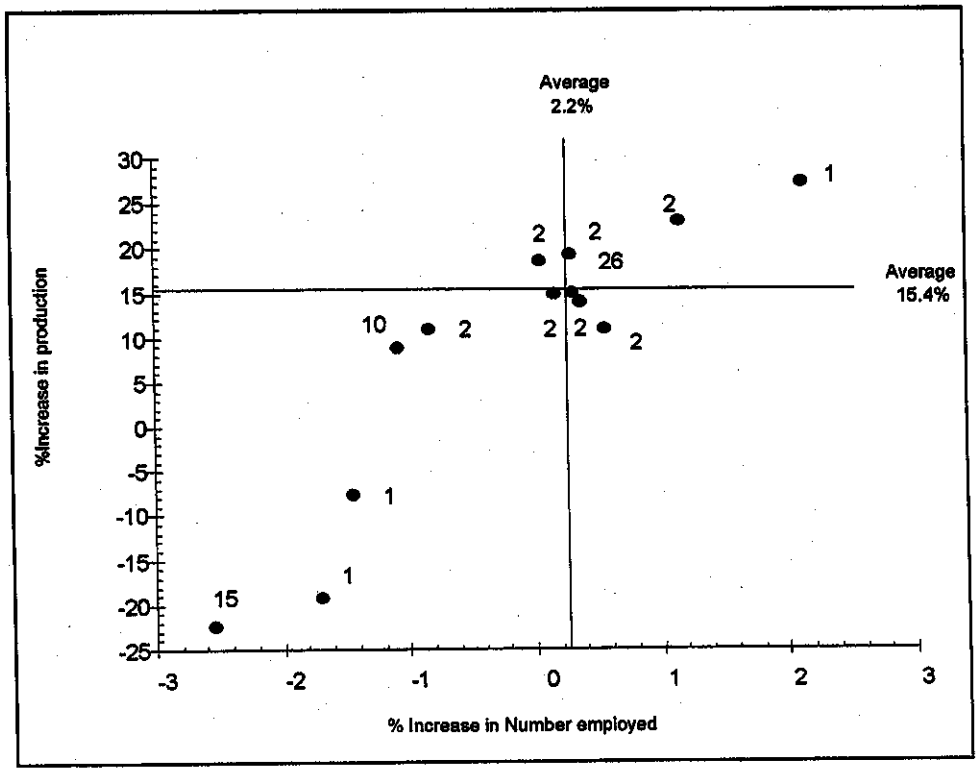


Figure 1b: Distribution of Industrial Branches in Germany According to Their Growth Rate in Production and Employment, 1987-1992 (Excluding Food, Wood, Paper and Printing)



Another group of industrial branches displayed a high rate of growth in employment, but a below-average rate of increase in production outputs. Industrial branches in Israel belonging to this group are printing and publishing (18), leather and its products (15), clothing and textile (14) and transport equipment (26). In Germany, industrial branches belonging to this group are non-metallic mineral products (21) and machinery (24). On the other hand, there is a group of industrial branches that grew above the average in the rate of production outputs, but below average in employment, a fact that points to an increase in output per employee. In Israel this group of industrial branches includes; basic metal (22) and chemical and its products (20); and in Germany, only miscellaneous (28).

The number of industrial branches that belong to the group of slower-growing industries is much larger in Germany than in Israel. (These are characterized by a below-average rate of growth in production outputs and a negative rate of growth in number of employee.)

Export Performance

Export is a determinant factor for growth in both countries' economies. Export performance reflect the exploitation of opportunities to achieve economic growth, particularly in a small country like Israel, where the extent of the local market is relatively small.

Two indices were used to measure the extent of export: (1) the export share in an industry's total turnover was used to differentiate between export-led industrial branches and industrial branches that rely mainly, or only, on the local market; (2) the change in an industry's export share that occurred during the time period examined. The export rate of change is measured as a ratio of the percentage of exports to total turnover. The results are presented in Table 3 and in Figures 2a and 2b.

In 1992, the average share of Israel's exports in its total production (excluding non-metallic minerals and wood and its products) was about one quarter (25%), a rate that remained relatively stable throughout the five-year period. In Germany, on the other hand, the export share in 1992 was higher than Israel's -- 30.5% (excluding food, beverages and tobacco, wood and its products, paper and its products, printing and publishing); however, this share decreased by approximately 9.5% overall during the period examined.

Table 3: Export Share and Its Change, 1987-1992

Code	Major Branch	Export share of total revenue (%) 1992		Change in export share (%) 1987-92	
		Isrl.	Ger.	Isrl.	Ger.
10	Mining and quarrying	37.2	6.8	-37.4	-37.3
11,12	Food beverages and tobacco	8.3	8.6	-17.0	-1.7
13	Textile	20.3	27.8	-1.2	5.0
14	Clothing and made-up textile	38.5	20.5	8.6	8.8
15	Leather and its products	5.8	20.8	65.8	17.2
16	Wood and its products	5.3	10.5	-25.8	-24.1
17	Paper and its products	5.0	25.5	76.5	-11.4
18	Printing and publishing	2.1	7.1	-23.7	2.5
19	Rubber and plastic products	24.2	21.5	27.0	-10.3
20	Chemical and oil products	36.9	27.1	-22.6	-11.9
21	Non-metallic mineral products	1.5	27.7	-34.6	-9.0
22	Basic metal	10.7	29.7	-28.8	-9.8
23	Metal products	25.4	18.6	-33.9	-14.2
24	Machinery	34.5	40.0	9.0	-9.6
25	Electrical and electronic equipment	44.5	29.8	12.3	-10.6
26	Transport equipment	34.9	43.0	-0.3	-10.2
28	Miscellaneous	87.9	32.9	1.8	-7.0
	Total	25.2	26.8	-1.9	-9.9
	Total adjusted[1]	27.0	30.5	-0.7	-9.5

1. The Israeli data do not include two industrial branches: non-metallic mineral products and wood and its products. The Germany data exclude four industrial branches: food, wood, paper and printing (explanation given in the text).

Figure 2a: Distribution of Industrial Branches in Israel, According to Their Export Performance (Excluding Wood and Non-metallic Mineral)

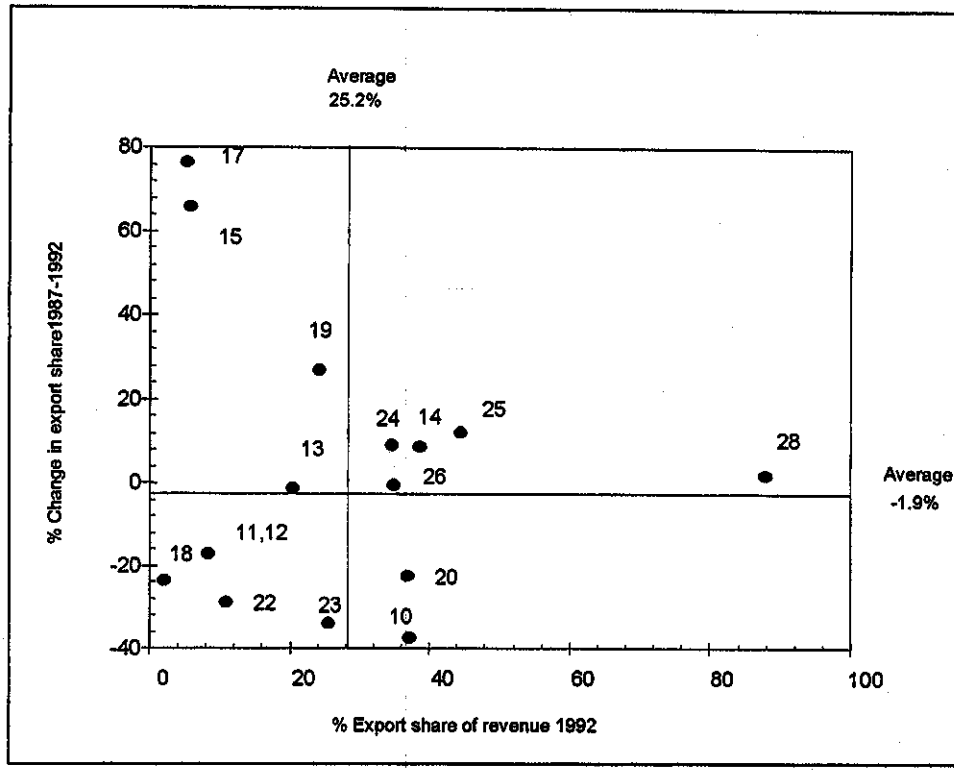
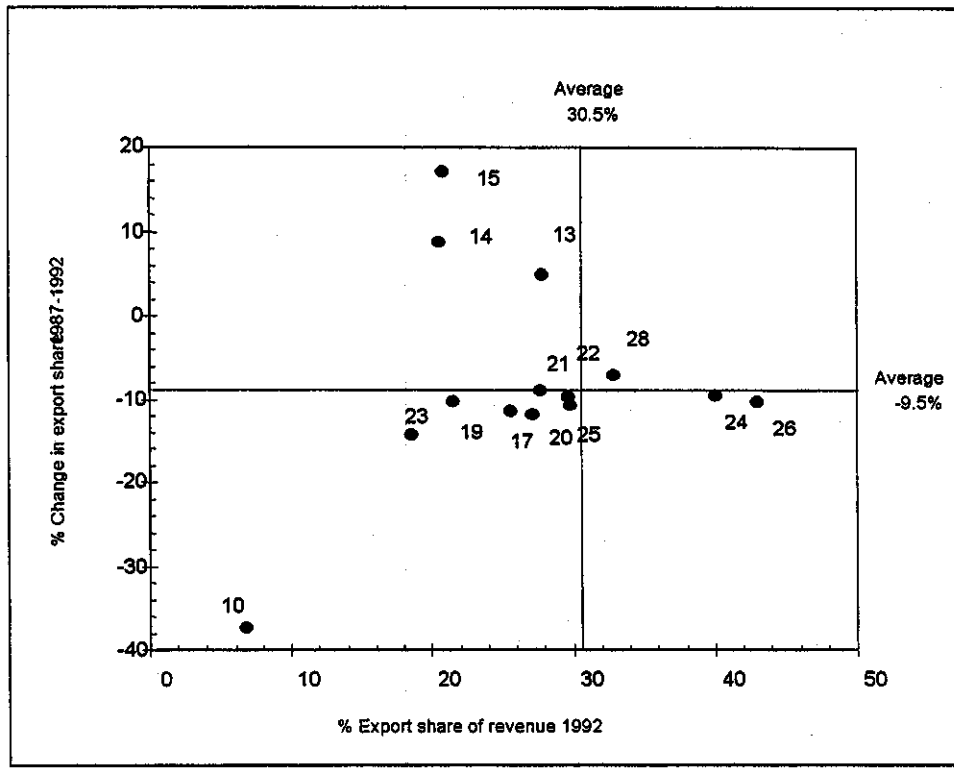


Figure 2b: Distribution of Industrial Branches in Germany, According to Their Export Performance (Excluding Food, Wood, Paper and Printing)



The distribution depicted in Figures 2a and 2b enable us to identify the outstanding exporting industrial branches and those sectors that produced mainly for the local market. The export trend which reveals itself in the change over time, is important in identifying growth potential and competitive advantage. The group of export-led industries (high export share together with real growth in export share over time) in Germany includes only miscellaneous (28); and in Israel, the following four industries: miscellaneous (28) - with a very high and stable export share (approximately 90%) - electric and electronic equipment (25), clothing and textile (14) and machinery (24). In all of these industrial branches, the export share amounted to 35%-44%. An additional Israeli industry is rubber and plastics (19), whose export share was close to the average, but which had a significant increase in export share during the same time period.

Table 4 shows the classification of industrial branches (except for those in Israel and Germany that were excluded for the reasons discussed above), based on the four criteria presented above.

Six fast-growing industrial branches were identified, of which three appear in both countries. These latter three are rubber and plastic products (19), metal products (23), and electrical and electronic equipment (25). The three other branches are fast growing in only one of the two countries: miscellaneous (28) in Israel, and machinery and transport equipment in Germany.

All but one of the fastest-growing industrial branches identified in Israel exhibit high performance, in that they scored high in at least three of the four indicators (except the metal products industry [23], which scored medium on production and change in export share indicators). Two of the industrial branches, electric and electronic equipment (25) and metal products (23), are large industrial branches that together employ about 28% of all industrial employees in Israel. Miscellaneous (28) and rubber and plastic (19) are smaller industries, but they displayed a high rate of growth in both production outputs and employment in the course of the period analyzed. Miscellaneous constitutes one of the country's leading export industries, while the rubber and plastic industries showed an accelerated increase in export share during the 1987-1992 period.

Table 4: Classification of Industrial Branches According to Four Growth Criteria

code	Major industrial branch	Increase in industrial production, 1987-1992	Increase in number of employees, 1987-1992	Export share, 1992	Change in export share, 1987-1992	Increase in industrial production, 1987-1992	Increase in number of employees, 1987-1992	Export share, 1992	Change in export share, 1987-1992
		ISRAEL				GERMANY			
10	Mining and quarrying	❖	□	□	□	□	□	□	□
11,12	Food beverages and tobacco	□	□	□	□	exc.	exc.	exc.	exc.
13	Textile	❖	□	❖	❖	□	□	❖	❖
14	Clothing and made-up textile	□	❖	□	□	□	□	❖	□
15	Leather and its products	❖	□	□	□	□	□	❖	□
16	Wood and its products	exc.	exc.	exc.	exc.	exc.	exc.	exc.	exc.
17	Paper and its products	❖	□	□	□	exc.	exc.	exc.	exc.
18	Printing and publishing	□	□	□	□	exc.	Exc.	exc.	exc.
19	Rubber and plastic products	◆	◆	❖	◆	◆	◆	❖	❖
20	Chemical and oil products	□	❖	□	□	❖	❖	❖	❖
21	Non-metallic mineral products	exc.	exc.	exc.	exc.	❖	❖	❖	❖
22	Basic metal	□	□	□	□	❖	□	❖	❖
23	Metal products	❖	◆	❖	◆	◆	◆	❖	❖
24	Machinery	□	❖	□	❖	❖	❖	◆	❖
25	Electrical and electronic equipment	◆	❖	◆	◆	◆	❖	❖	❖
26	Transport equipment	□	❖	□	❖	❖	❖	◆	❖
28	Miscellaneous	◆	◆	◆	❖	□	❖	❖	❖

exc. = excluded

Legend

categories	Increase in industrial production 1987-1992	Increase in number of employees 1987-1992	Export share 1992	Change in export share 1987-1992
□ = low	<10%	<0%	<18%	<-15%
❖ = medium	10%-16%	0%-10%	18%-34%	-15% - 5%
◆ = high	>16%	>10%	>34%	>10% ISR.; >5% GER.

In Germany, most of the fast-growing industries received a high score on at least two of the four indicators. Four of the five industries (the exception being rubber and plastic products [19]) are large industries, employing altogether 53.3% of all industrial employees in Germany.

With respect to the rate of export growth, leather, clothing and textiles can be classified in the group of fastest-growing industrial branches in Germany; at the same time, however, these industries display a decrease in production outputs as well as employment (see industries 13, 14 and 15 in Figure 2b). Therefore, they were not classified in our analysis in the group of fastest-growing industrial branches.

In all, four industries were classified in the group of fastest-growing industrial branches in the two countries:

- rubber and plastic products (19),
- metal products (23),
- electric and electronic equipment (25),
- miscellaneous (28).

The three first branches are fast-growing industries in both countries. The fourth, miscellaneous (28), was classified as a fast-growing industry only in Israel. Despite its low percentage of employees in Germany, it was decided to include this industry in the empirical analysis.

Classification According to Expenditures on R&D

Unlike the four former criteria no important differences emerged when using the three R&D indices as an additional criterion in identifying the fastest-growing industrial branches in both Israel and Germany (see Table 5). Since the R&D statistics are available only at a relatively high level of aggregation, it was not possible to omit the following industries in Germany: food and tobacco, textile and clothing, leather, quarrying, wood and its products, paper and its products, printing and publishing.

Table 5: Changes in R&D Indices, 1987-1992

code	Major Industrial Branch	Change (%) in Number of Employees in R&D, 1987-1992		Change (%) in Expenditure on R&D 1987-1992		R&D Intensity, 1991	
		Isrl.	Ger.	Isrl.	Ger.	Isrl.	Ger.
19	Rubber and plastic products	107.4	-17.5	142.0	7.1	0.8	2.4
20	Chemical and oil products	65.8	-5.6	149.5	12.8	1.7	4.8
22,23	Basic metal and metal products	-11.8	-24.4	-3.7	20.9	0.4	1.0
24, 26, 28	Machinery, transport equipment and miscellaneous	13.3	6.8	18.7	58.6	2.2	4.9
25	Electrical and electronic equipment	56.1	-10.6	102.8	12.9	6.8	6.7
	Total	46.1	-3.2	85.4	31.3	2.8	3.8

Source: Germany - SV-Wissenschaftsstatistik
Israel - Central Bureau of Statistics

The data in Table 5 testify to the rapid growth in expenditures on R&D in the Israeli industrial branches. There was a tremendous increase in the number of employees engaged in R&D in most of the industrial branches (except for metal and metal products[23]), with a 46% average increase between 1987 and 1992, and an even larger growth in expenditures on R&D - 85% -- during the same period. In Germany by comparison, the average growth rate of expenditures on R&D, over the same period of time, was much smaller - only 31%. In addition, there was a reduction of 3% on average in the number of employees engaged in R&D in most industries (except for machinery and transport equipment).

On the other hand, R&D intensity (R&D expenditures measured as a percentage of total turnover) was higher in Germany than in Israel. The average for the German industrial branches in 1991 was about 3.8%, while it was only 2.8% for Israel. In almost all industrial branches, German R&D intensity is found to be larger than Israeli R&D intensity; an exception was electrical and electronic equipment, which had identical figures of 7%.

In 1992, the four selected fastest-growing industrial branches together accounted for about 30%-34% of all R&D employees and R&D expenditures in Germany, and for more than double that in Israel (68%-71%). Electrical and electronic equipment and miscellaneous -precision instruments and tools industries - are found to have an above

average rate of growth in both Israel and Germany and thus were classified as technology-intensive (over 3.5%) or as a high-tech industrial group with a clear potential for growth.

On the other hand, we classified rubber and plastic products and metal products among the more traditional group of industries.

Analyzing the Rate of Innovation

Following the methodology developed in this paper, a random sample of over 400 firms belonging to the group of fastest-growing industries was interviewed in Germany and Israel. In Israel, 211 firms located in the Northern region were personally interviewed; and in Germany, 220 firms located in the Federal State of Baden-Württemberg replied to a mail questionnaire.

The objective of this second stage of our study was to test the hypothesis concerning the prevalence of industrial innovations in the group of fastest-growing industries in Germany and Israel.

Further, we made use of the distinction between the group of firms belonging to the Hi-tech fastest-growing industries and the group of firms belonging to "traditional" fastest-growing industries.

Table 6 presents the results of the null hypothesis, which states that there is no difference in the rate of innovation between Israel and Germany in Hi-tech and "traditional" firms. As can be discerned from the statistical results, there is no significant difference among the rates of innovation in the group of Hi-tech firms. There exists, however, a statistically significant difference among the rates of innovation in the group of "traditional" firms. In Israel, the rate of innovation in this group of firms is statistically and significantly higher than in Germany. This could be due to the age distribution of the firms analyzed in Israel compared to Germany.

Table 7 presents the results of the null hypothesis concerning the rate of innovation in Hi-tech and "traditional" firms within each country. As can easily be discerned from the statistical results, a significant difference exists between these two groups of firms in all the analyses carried out in Israel, in Germany, and in the two groups of firms in the two countries when the data are pooled.

In all of these cases, the rate of innovation in the Hi-tech firms was found to be statistically and significantly higher than that found in the "traditional" firms.

These findings corroborate our hypothesis that firms belonging to the group of Hi-tech industries have a greater probability of engaging in innovation. This is a significant finding that could assist us in designing effective public policies aimed at inducing regional innovation.

Table 6: Distribution of Firms by Rate of Innovation in Israel and Germany (%)

Innovation	Hi-tech industries		Traditional industries	
	Israel	Germany	Israel	Germany
Innovative firms	74.4	77.2	49.6	36.5
Non-Innovative firms	25.6	22.8	50.4	63.5
Total	100.0	100.0	100.0	100.0
N	86	92	125	115
χ^2	0.1842		4.172	
p	0.671		0.039	

Table 7: Comparison of Rate of Innovation Between Hi-tech and Traditional Industries (%)

Innovation	Israel		Germany		Israel + Germany	
	Hi-tech	Traditional	Hi-tech	Traditional	Hi-tech	Traditional
Innovative firms	74.4	49.6	77.2	36.5	75.8	43.3
Non-Innovative firms	25.6	50.4	22.8	63.5	24.2	56.7
Total	100.0	100.0	100.0	100.0	100.0	100.0
N	86	125	92	115	178	240
χ^2	13.05		34.07		44.11	
P	0.000		0.000		0.000	

Conclusions

The present paper reported on a methodology developed and used in the process of identifying the fastest-growing industrial branches. In subsequent studies, we made use of the classifications presented in this paper. It guided us in randomly selecting samples of firms, from which we collected the data to compute the rate of innovation.

We hypothesized that innovation, is more prevalent in the group of fastest-growing industries than in the group of slower-growing industries. The rates of production, employment, and export growth were used as indices for classifying manufacturing industries in Germany and Israel. These primary indices were augmented by the rate of R&D activity, measured by the change in the percentage of employees engaged in R&D, the change in the total expenditures on R&D, and the intensity of R&D activities in each industry. Four major industrial branches were identified in the group of fastest-growing industries in the two countries. Two industrial branches - electric and electronic equipment, and miscellaneous - were classified in the group of high-tech industries while the other two fastest-growing industrial branches - rubber and plastic products and metals products - were classified in the group of more "traditional" industries.

Bibliography

Barro, R.J. and X Sala-i-Martin (1995). *Economic Growth*, New York: McGrew Hill.

Bertuglia, C.S., S. Lombardo, and Nijkamp, P. (eds.) (1997). *Innovative Behaviour in Space and Time*. Berlin: Springer.

Bertuglia, S.C., M.M. Fischer and G. Preto (eds.) (1995). *Technological Change, Economic Development and Space*, Berlin: Springer.

Camagni, R.P. (1995). "The Concept of Innovative Milieu and Its Relevance for Public Policies in European Lagging Regions", *Papers in Regional Science*, Vol. 74, No. 4, pp. 317-340.

Camagni, R.P. (ed.) (1991). *Innovation Networks: Spatial Perspectives*. London: Belhaven Press.

Davelaar, E.J. and P. Nijkamp (1989). "The Role of the Metropolitan Milieu as an Incubation Center for Technological Innovation: A Duch Case Study." *Urban Studies*, Vol. 26, pp. 517-525.

Dieperink, H. and P. Nijkamp (1988). "Innovative Behavior, Agglomeration Economies and R & D Infrastructure." *Empec*, Vol. 13, pp. 35-57.

Dieperink, H. and P. Nijkamp (1990). "The Agglomeration Index." *Geography Research Forum*, Vol. 10, pp. 20-28.

Dosi, G. (1988). "Sources, Procedures, and Microeconomic Effects of Innovation", *Journal of Economic Literature*. Vol. XXVI, pp. 1120-1171.

Freeman, C. Clark, J. and Soete, L. (1982). *Unemployment and Technical Innovation. A Study of a Long Waves and Economic Development*, London: Frances Printer.

Frenkel, A., and D. Shefer (1997). "Technological Innovation and Diffusion Models: A Review." In: *Innovative Behavior in Space and Time.* C.S. Bertuglia, S. Lombardo, P. Nijkamp (eds.). Berlin: Springer. pp. 41-63.

Frenkel, F., Shefer, D., Koschatzky, K. and Walter, G.H. (1998). *Firms Characteristics, Location, and Regional Innovation: A Comparison Between Israeli and German Industrial Plants.* Neaman Institute, Technion, Haifa. (Forthcoming Working Paper).

Gehrke, B. and Grupp, H. (1994). *Innovationspotential und Hochtechnologie Technologische Position Deutschlands in Internationalen Wettbewerb*, Heidelberg: Physica.

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 (1991a). "Endogenous Product Cycles." *Economic Journal*, Vol. 101, September, pp. 1214-29.

Grossman, G.M. and E. Helpman (1991b). *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.

Koschatzky, K. (1997). Innovative regional development Concepts and Technology – Based Firms.". In: Koschatzky, K. (ed.), *Technology – Based firms in the Innovative Process*, Hiedelberg: Physica. pp. 177-201.

Krugman, P. (1990). *Rethinking International Trade*, Cambridge MA: MIT Press.

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.

Lucas R.E. Jr. (1988). "On the Mechanics of Economic Development." *Journal of Monetary Economics*, Vol. 22, No. 1, pp. 3-42.

Nelson, R.R. and Winter, S.G. (1982). *An Evolutionary Theory of Economic Change*, Cambridge, MA: Belknap Press Harvard University.

Noponen, H., J. Graham and A.R. Marjusen (1993) *Trading Industries, Trading Regions*, New York: Guilford Press.

Pack, H. (1994). "Endogenous Growth Theory: Intellectual Appeal and Empirical Shortcomings", *Journal of Economic Perspectives*, Vol. 8, No. 1, pp. 5-72.

Porter, M.E. (1990). *The Competitive Advantage of Nations*, New York: The Free Press.

Romer, P.M. (1986). "Increasing Returns and Long-Run Growth", *Journal of Political Economy*, (Oct.), Vol. 94, No. 5, pp. 1002-1037.

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.

Schmookler, J. (1966). *Invention and Economic Growth*, Cambridge, MA: Harvard University Press.

Schumpeter, J.A. (1934). *The Theory of Economics Development*, Cambridge, Mass: Harvard University Press.

Segerstrom, P.S. (1991). "Innovation, Imitation and Economic Growth", *Journal of Political Economy*, (August), Vol. 99, No. 4, pp. 807-827.

Shefer, D. and E. Bar-El (1993). "High-Technology Industries as a Vehicle for Growth in Israel's Peripheral Regions", *Environment and Planning C, Government and Policy*, Vol. 11, pp. 245-261.

Shefer, D. and Frenkel, A., (1998). "Local Milieu and innovativeness: Some Empirical Results". *The Annals of Regional Science*, Vol. 32, pp. 185-200.

Solow, R.M. (1956). "A Contribution to the Theory and Economic Growth", *Quarterly Journal of Economics* (Feb.) Vol. 70, pp. 65-94.

Solow, R.M. (1970). *Growth Theory: An Exposition*. Oxford: Oxford Uvniversity Press.

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

Suarez-Villa, L. and Walrod, W. (1997). "Operational Strategy, R&D and Intra-metropolitan Clustering in a Polycentric Structure: The Advanced Electronics Industries of the Los Angeles Basin", *Urban Studies*, vol. 34, No. 9, pp. 1343-1380.

Thwaites, A.T. R.P. Oakey and P.A. Nash (1981). "Industrial Innovation and Regional Development." Final report to the Department of the Environment; CURDS, University of Newcastle upon Tyne, Newcastle upon Tyne, U.K.

Tödtling, F. (1990) *Röumliche Differenzierung beterieblicher Innovation. Erklärungsansätze und empirische Befunde fur Osterreichische Regionen*, Berlin: Edition Sigma.

Appendix B

Fast Growing Industries as a Target Group for Regional Policy – A Comparison Between German and Israeli Industrial Firms

Knut Koschatzky*, Guenter H. Walter*, Amnon Frenkel, Daniel Shefer****

Submitted to *Policy Research*

* Fraunhofer Institute for Systems and Innovation Research, Karlsruhe, Germany.

** S. Neaman Institute for Advanced Studies in Science and Technology, Technion - Israel Institute of Technology, Haifa, Israel.

Abstract

Comparing the regional distribution of selected, fast growing industrial firms within and between different German and Israeli sub-regions, the statement is made in this paper that fast growing industries can well contribute to interregional decentralisation of industrial activity in these two countries and are therefore an important target group for regional policy. Analysing the regional and sectoral distribution of different characteristics of firms such as age, employment, turnover, R&D employment, R&D expenditure, and innovative activity, no clear evidence for a centre-periphery dichotomy in the location pattern of fast growing industries was found for the German regions, while in Israel especially R&D-intensive industrial branches like electronics rely more heavily on the proximity to urban agglomeration. This branch also supports industrial decentralisation to intermediate regions. The two other fast growing industries, metal products and plastics, significantly contribute to employment and income in Israel's peripheral regions in particular. Above average industrial growth can be linked to peripheral development, if infrastructural and human capital development are made important aims in regional innovation policy.

Key Words: fast growing industry, regional distribution, industrial decentralisation, R&D activity, regional innovation policy

1. Spatial aspects of fast growing industries

Economic growth is generally associated with competitive advantage. Competitive industrial clusters and regions grow faster than those with outdated products or processes (Porter 1990). Competitiveness can be increased by the utilisation of modern technology for production, organisation and marketing. The contribution of innovation to regional development is extensively reported in the literature which underlines the significant role played by innovation in fostering regional economic growth (Davelaar and Nijkamp 1997; Feldman and Kutay 1997). According to spatial growth theory, external effects resulting from the access to technology, knowledge and information can best be realised in urban, industrialised regions (e.g. Isard 1956). Such regions become a preferred destination for highly-skilled labour and are an attractive location for major corporate head-offices which subsequently impact the regional education infrastructure and knowledge base (Suarez-Villa 1993). Human capital accumulation, specialisation in production and increasing returns of production and knowledge are important determinants which trigger regional concentration, spatial disequilibrium and increasing regional disparities. This view is supported by some models of new growth theory (e.g. Romer 1986; Romer 1987; Lucas 1988; Grossman and Helpman 1990; Grossman and Helpman 1991) and by the spatial version of the product life-cycle hypothesis: during the development, market introduction and first growth phase of a product the fastest growth of industrial production is attributed to metropolitan regions. In the maturity and declining phase, determined by standardised mass production and diminishing returns, the optimal location for production is shifting from the centre towards the periphery, resulting in intraregional, interregional and international decentralisation processes (Duijn 1984; Hampe and Koll 1989; Schätzl 1996). It is assumed therefore that regions characterized by a high rate of innovation will enjoy greater economic growth by comparison with other areas (Krugman 1995; Stokey 1995). Nevertheless, there is no automatic tendency towards spatial concentration and dispersal since not all innovations are generated and realised in metropolitan areas and there is also no evidence that during the maturity stage the only option for industry is to shift production to the periphery (Tichy 1991). As the results of several empirical studies indicate, different regions play unique and separate roles in innovation (Davelaar 1991; Oakey 1984, Simmie 1997). Innovative activity is not only confined to metropolitan regions. It can also be found in peripheral areas, although the kind of innovation and the innovation strategies of firms might differ from those applied by firms located in central regions, e.g. depending on the availability of skilled labour (Koschatzky 1997). Different processes

of location and relocation might occur, depending on market developments, the economic and innovative structure of regions and on entrepreneurial decisions. Nevertheless, a general pattern emerges in which peripheral regions are often characterized by a lower innovation capability (Frenkel 1997).

Not only because of their factor endowment, but also because of the uncertain and risky nature of innovative activity (Kline and Rosenberg 1986; Dosi 1988), certain regions are favoured as location of innovative, growth-intensive industries compared to others. For innovators, one means for the reduction of uncertainty and risk is to participate in information and knowledge exchange networks (Feldman 1993; Freeman 1991). This is especially true for uncodified tacit knowledge and for knowledge which can only be learned through practice and doing (Arrow 1962; Nelson and Winter 1982) or which refers to emerging and complex technologies. Here information cannot be standardised but only transferred through face-to-face contacts (Hoover and Vernon 1959; Vernon 1960; Saxenian 1990). Spatial and cultural proximity between the actors in the innovation process therefore reduces uncertainty and in this way favours the spatial concentration of innovative and economic activity (Porter 1990).

At least since the basic contributions of Schumpeter to economic development theory there is ample evidence that innovative activity, be it product or process innovation, positively affects the performance and growth potentials of individual enterprises (Geroski and Machim 1992; Kleinknecht 1996; Nelson and Winter 1982). Due to their higher propensity for knowledge spillovers (Jaffe et al. 1993; Feldman and Florida 1994), innovative, fast growing industries are expected to be mostly located in central, metropolitan regions where knowledge and information is closely available, while less dynamic industries are said to be mainly located in rural, peripheral areas (Lloyd and Dicken 1972; Eliot Hurst 1973; Armstrong and Taylor 1993). The concentration effects towards industrial agglomerations are further exaggerated by the role fast growing industrial branches play themselves. These industries can be regarded as important producers and users of new production technology and serve as focal points for the diffusion of new technologies as well. Regions endowed with these industries may show a great acceleration of economic growth.

Although not all growth of a firm might be attributed to technological innovation alone, but can be a result of branch and firm characteristics, organisational innovations as well as market conditions, it can nevertheless be assumed that innovative

activity and growth of firms are closely linked.. With respect to growth in employment and turnover, the regional innovation policy interest in fast growing industries is therefore at least twofold. Firstly, the spatial distribution of different fast-growing industrial branches provides information about the locational preferences of firms and the importance of external effects for innovation and production. Secondly, because of their networking intensity and their contribution to employment generation and income, fast growing industries seem to be an interesting target group for strengthening regional economic and innovation potentials in non-metropolitan regions. Although the propensity of these firms to locate in central, urban regions seems to be higher than to locate in peripheral areas, it should not be concluded that fast industrial growth is impossible under the conditions of a peripheral economy. It is therefore the objective of this paper to analyse the regional distribution of fast growing industries and structural characteristics of the firms with respect to different regional environments in order to obtain some insights into the innovative behaviour and locational preferences of these industries.

To apply the analysis to different regional and economic backgrounds, industrial survey data from both Germany and Israel will be used. Germany serves as an example of a traditionally decentralized industrial economy, while Israel represents a growth intensive economy in which both industry and agriculture significantly contribute to income and employment. Following the empirical results the question will be raised as to whether fast growing industries are a means for reducing interregional imbalances in industrial activity within the two states.

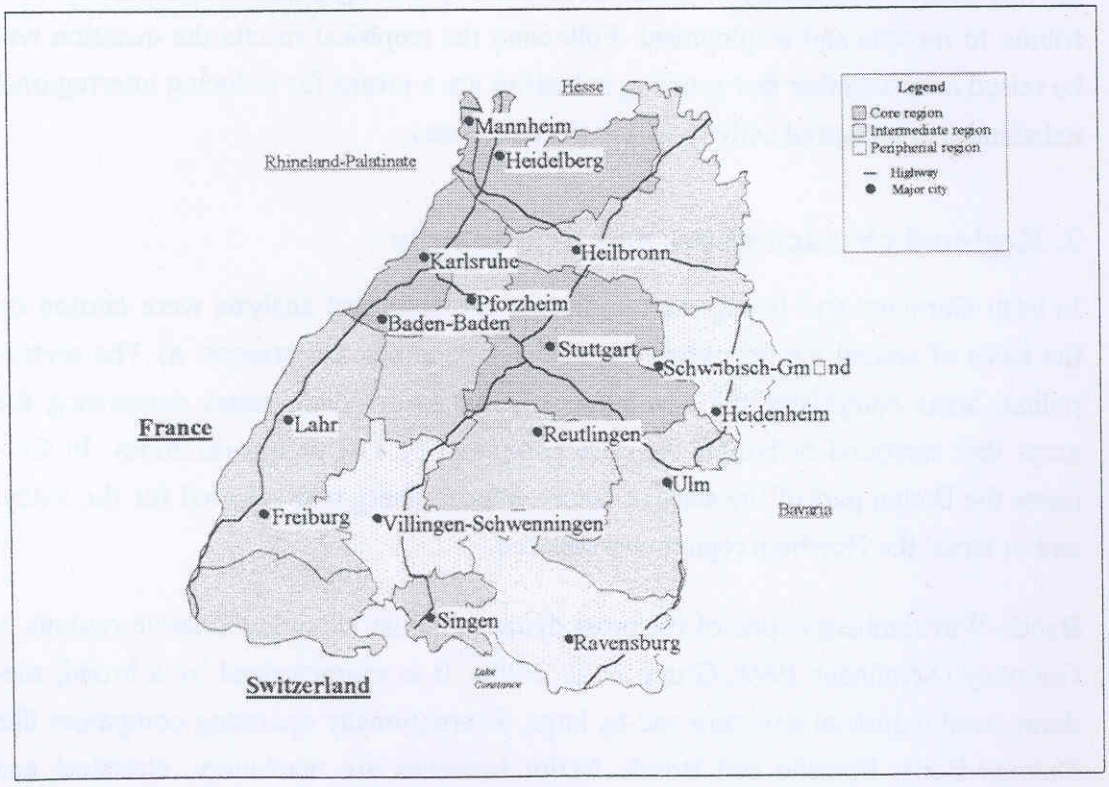
2. Regional characteristics and firm sample

In both Germany and Israel, the regions for the empirical analysis were chosen on the basis of spatial entities where three types of zones are present: a) The metropolitan areas comprising the core zone; b) The intermediate zones comprising the areas that surround or border the core zone; and c) The peripheral zones. In Germany the Baden part of the state of Baden-Württemberg was selected for the study, and in Israel the Northern region was selected.

Baden-Württemberg is one of the most dynamic industrial and innovative regions in Germany (Semlinger 1993; Grupp et al. 1998). It is characterized by a broad, medium-sized industrial structure and by large, internationally operating companies like Daimler-Benz, Porsche and Bosch. Major branches are machinery, electrical and

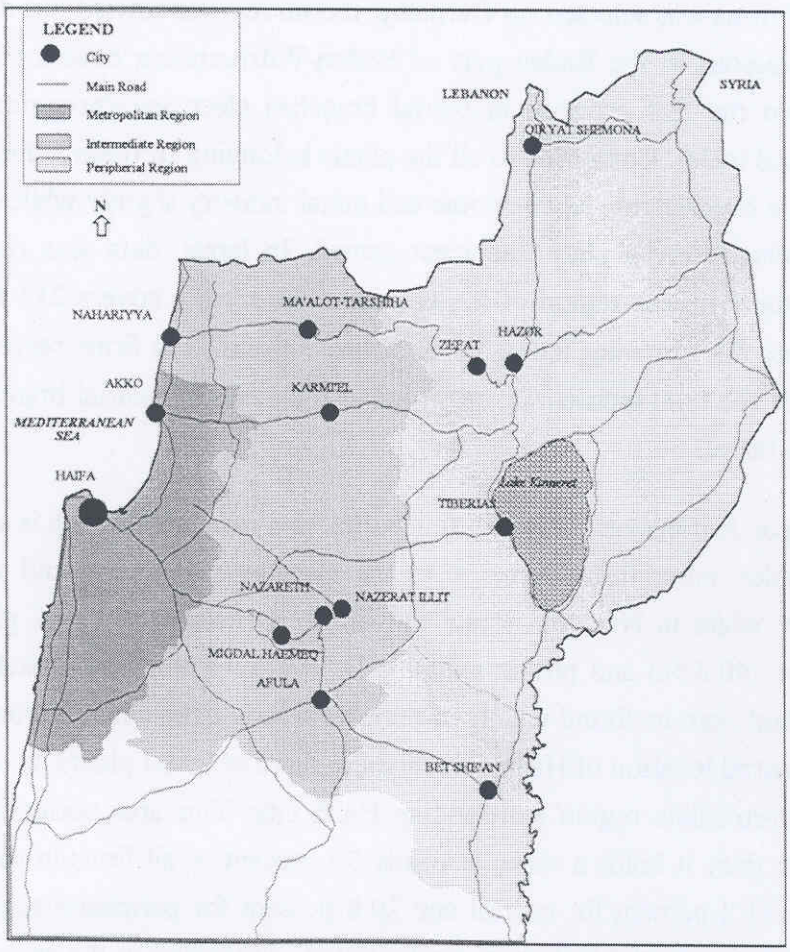
electronic equipment, transport equipment, and metal products. The "Mittelstand" of Baden-Württemberg and innovation supporting institutions like Steinbeis transfer centres, Fraunhofer Institutes, universities, technical colleges and others are seen as important economic success factors in this federal state (Braczyk et al. 1995; Cooke et al. 1993; Cooke and Morgan 1994; Krauss 1996). Baden Württemberg consists of 12 planning regions (Raumordnungsregionen) of which three cover the area under investigation. Baden forms the western part of Baden-Württemberg, situated along the Rhine river and reaches up to parts of the Black Forest (Fig. 1). It consists of the three regions "Mittlerer Oberrhein", an urbanized area and economically dominated by Karlsruhe (central zone), "Südlicher Oberrhein" with its capital Freiburg (intermediate zone) and "Schwarzwald-Baar-Heuberg", situated in the hilly Black Forest with its major double-city Villingen-Schwenningen (peripheral zone). Compared to the agglomeration of Stuttgart, Baden's economy has a strong focus on services, especially in the Karlsruhe and Freiburg area, whereas Schwarzwald-Baar-Heuberg is still an industrial region. At the end of 1995 Baden had 2.4 million inhabitants, constituting about 23 percent of the total population of the state of Baden-Württemberg.

Figure 1: Regional division in Baden-Württemberg



In Israel, the northern part is one of the most fascinating regions in the country. This is because of the composition of its residents (Jews and non-Jews, veteran settlers as well as new and qualified immigrants) and its settlement structure. In 1995, some 1.4 million people, constituting about 26 percent of the Israeli population, resided in the region which covers 23 percent of the total land area of the state. Between 1990 and 1995 the population growth rate was very rapid (almost 3 % per annum), mainly due to the large waves of immigrants who migrated to Israel since 1990 from the former Soviet Union (Frenkel et al. 1997). The northern region can be divided into Haifa Metropolitan Area (central zone), Central Galilee surrounding the central zone (intermediate zone), and Eastern Galilee (peripheral zone; see Fig. 2). Although the three types of areas differ between Germany and Israel in their economic structure and public infrastructure supply, it will nevertheless be interesting to analyse differences and similarities in the location pattern of fast growing industries in both countries.

Figure 2: Regional division in Northern Israel



Identification of the fast growing industries was based on the analysis of the rate of growth in output, employment and export as well as on R&D-empoyment intensity in each of the 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 fast 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 the 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 compared to industries which rely mainly on local markets (cf. Shefer *et al.* 1998 for full description of the methodology used for the identification of fast growing industries). Thew same holds true for above average R&D-intensity as an input indicator for innovation. Innovative firms generally serve a much wider market range than less-innovative firms (Koschatzky 1999).

The data used in this paper originates from two field surveys by which a sample of industrial firms was selected. In Germany, the survey was carried out during 1995/96 in three regions in the Baden part of Baden-Württemberg covering 220 industrial firms from the fast growing industrial branches electronics/precision instruments, plastics and metal. Compared to all the plants belonging to these industrial branches, the sample overweighs the electronic and metal industry slightly while firms from the plastic industry are slightly underrepresented. In Israel, data was collected during 1995 in the northern region of the country. The sample covers 211 firms from the same three fast growing industrial branches. Overall, the firms represent about 72 percent of the total industrial firms from fast growing industrial branches located in Northern Israel.

The sample distribution according to location and industrial branch is shown in Table 1. In Baden most firms come from the electronic (44.5 %) and metal industry (42.7 %), while in Northern Israel the sample consists mainly of plants from the electronic (40.8 %) and plastic industry (37.9 %). In Northern Israel, plastic processing plants can be found mainly in peripheral locations, while electronic firms prefer the central location of Haifa. The highest share of metal plants have their location in the intermediate region surrounding Haifa city. This area seems to be the most attractive since it holds a share of nearly 39 percent of all firms in the sample compared to 31.3 percent for central and 29.8 percent for peripheral regions. In Baden an opposite regional distribution can be found. According to the sample, the periph-

eral region of Schwarzwald-Baar-Heuberg is much more industrialized than the other two regions of Karlsruhe and Freiburg. This is not only reflected by a share of 48.2 percent of all plants in the Baden sample which are located in the peripheral region, but also by a greater contribution by the manufacturing sector to the local economy of Schwarzwald-Baar-Heuberg in general. Based on fine mechanics, wood and metal production, the watch-making industry dominated this region for decades. Acquired qualifications in the handling and producing of small parts serves as a basis of recent diversifications towards micromechanics and microsystems technology. According to official employment statistics, manufacturing employment reached 51.8 percent of all employees in Schwarzwald-Baar-Heuberg in 1995, while it reached 34.5 percent in Karlsruhe (central region) and 33.8 percent in the intermediate region of Freiburg (Statistisches Landesamt Baden-Württemberg 1997). It is the aim of the following section to analyse structural differences and similarities of the firms with respect to the different regional environments.

Table 1: Distribution of the samples by location and industrial branch (in %)

	Electronics		Plastics		Metal		Total	
Type of region[a]	Baden n=98	N.Israel n=86	Baden n=28	N.Israel n=80	Baden n=94	N.Israel n=45	Baden n=220	N.Israel n=211
Central	19.4	41.9	46.4	18.8	23.4	33.3	24.5	31.3
Interm.	34.7	39.5	25.0	36.2	20.2	42.2	27.3	38.9
Periph.	45.9	18.6	28.6	45.0	56.4	24.5	48.2	29.8
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[a] Type of region: central, intermediate, periphery

3. Regional and structural characteristics of fast growing firms

The two samples allow intra- and interregional comparisons of different firm related variables with respect to industrial branches and type of location. Using analysis of variance (ANOVA) it is the aim of this section to provide some statistical results about the distribution of the samples and to test the significance of regional disparities in the spatial distribution of fast growing industries within and between Baden and Northern Israel. In the following tables the F-values and their significance level (Sig) indicate whether significant or insignificant deviations from the null hypothesis of equal distribution can be found. F-values significant at the 10 % level or lower are printed in bold type. They are given for each country for location and industry and also on a two-way basis for cross-country comparison between location and indus-

try. Although ANOVA is based on mean values, we decided to also present the median to provide additional information about the distributional characteristics of the samples.

3.1 Age of firms

For all three industrial branches, Israeli firms are much younger than their German counterparts. The average age of fast growing industries in Baden is 32.5 years compared to 17.2 years in Northern Israel. It is interesting to see from Table 2 that in Israel the average firm age is nearly the same in central and peripheral regions, while in the intermediate zone the plants are much younger. This is particularly the case for electronic plants which reach an age of only 9.5 years. The fairly young industrial structure is an indication for industrial sub-urbanisation effects which started only quite recently. On the other hand, a more developed industrial base exists in the central region of Haifa and in Eastern Galilee. These regional age disparities are highly significant as can be seen from the F-value for location in Table 2. With respect to branches electronic firms with an average age of 14.3 years are significantly younger than plants in the two other branches

Table 2: Average age of plants by industrial branch and location

(years; reference 1995)

Location	Distribution measure	Electronics		Plastics		Metal		Total	
		Baden	N.Israel	Baden	N.Israel	Baden	N.Israel	Baden	N.Israel
Central	Mean	19.1	16.8	21.3	19.6	33.1	25.0	25.3	19.4
	Median	14.0	17.0	27.0	19.5	27.5	22.0	21.5	18.5
Intermediate	Mean	30.5	9.5	32.4	15.5	45.3	14.6	35.4	12.8
	Median	27.5	8.0	27.0	10.0	35.0	9.0	27.5	8.5
Periphery	Mean	40.6	19.5	20.6	18.9	31.9	25.7	34.6	20.2
	Median	22.0	18.0	24.5	19.5	26.0	25.0	25.0	20.0
Total	Mean	32.7	14.3	23.9	18.4	34.9	20.8	32.5	17.2
	Median	23.0	14.3	26.0	19.5	27.0	19.0	25.5	16.0

ANOVA results:

	Location:		Industry:		Cross-Country: 2-Way	
Baden:	F=1.987	Sig=0.140	F=2.182	Sig=0.115	**Country-Location:**	**Country-Industry:**
N.Israel:	**F=10.431**	Sig=0.000	**F=4.669**	Sig=0.010	**F=5.173**; Sig=0.006	F=0.983; Sig=0.375

In Baden, on the other hand, the younger firms are especially located in the central region of Karlsruhe (average age 25.3 years), mainly because of electronic plants. The median for this branch indicates that 50 percent of the firms are only 14 years

old, compared to 23 years for all plants of this industry in Baden. Astonishingly, the difference between the mean and the median for the electronic industry in Baden's periphery makes it clear that this branch has a long tradition in this region starting from a base of fine mechanics and measurement technology in the last century. Altogether, there are only slight age deviations in the firm age between Baden's intermediate and peripheral region (firms are around 35 years old), while the firms in the central region are about 10 years younger. Nevertheless, these differences are statistically insignificant.

Comparing the average age of fast growing industries between the two countries the significance levels of the F-values given in the two-way ANOVA statistics allow the statement that there is no equal age distribution between Baden and Northern Israel (as the null hypothesis would suggest), but a significant unequal distribution (F = 5.173 significant at the 1 percent level). This is mainly due to the already mentioned differences between the three types of locations. Cross country differences between industry types are statistically insignificant.

3.2 Firm size (Employment)

According to Table 3, fast growing industrial plants are slightly larger in Baden (107 employees) than in Northern Israel (97 employees). Despite these minor differences the figures emphasize the major contribution of SMEs to fast growing industrial branches in the two case-study regions. This is especially true for Northern Israel where the largest plant has 930 employees compared to 2,000 in the Baden sample. In Baden the intermediate region comprises the largest fast growing industrial plants. Their average size of 169 employees exceeds the average plant in Baden by more than 50 percent. Corresponding to the younger industry in the central region of Karlsruhe, the firms are much smaller here (51 employees). Nevertheless, these regional differences are statistically insignificant. The greatest size deviations can be found in the electronic industry, which is characterized by small enterprises in Karlsruhe. Here many information technology and software producing firms are located. The technical university of Karlsruhe and other research institutes are strongly oriented towards these technological fields. There are several spin-off firm foundations from the different research institutes which highlight the specific innovative potential of this technology region (Walter 1997). The normal distribution is supported only by the slight difference in mean (58.8 employees) and median (38 employees), while for the intermediate and peripheral region of Baden the difference is

much more marked - pointing to skewed distribution there due to the existence of some big plants. On the other hand, fast growing industrial plants in electronics in the two other German regions are strongly attributed to semiconductor production, the manufacturing of electronic devices and to communication technology. Branch differences in the average size of plants are statistically significant for Baden, although only at the 10 percent level.

Table 3: Average size of plants by industrial branch and location

(Number of employees 1995)

Location	Distribution measure	Electronics		Plastics		Metal		Total	
		Baden	N.Israel	Baden	N.Israel	Baden	N.Israel	Baden	N.Israel
Central	Mean	58.8	130.8	42.5	117.0	50.0	101.1	51.3	120.7
	Median	38.0	28.0	31.0	38.5	24.5	65.0	30.5	36.5
Intermediate	Mean	215.7	115.3	146.4	76.0	93.9	81.8	169.1	93.6
	Median	50.0	62.5	28.0	50.0	32.0	60.0	45.5	58.0
Periphery	Mean	172.3	82.9	54.5	73.3	46.7	83.8	100.6	77.6
	Median	40.0	45.0	32.0	70.0	28.0	60.0	30.0	60.0
Total	Mean	165.4	112.6	71.9	83.7	57.0	88.8	107.2	96.6
	Median	45.5	47.5	29.5	60.0	28.0	60.0	32.5	54.0

ANOVA results:

	Location:		Industry:		Cross-Country: 2-Way	
Baden:	F=2.152	Sig=0.119	F=**2.903**	Sig=0.057	**Country-Location:**	**Country-Industry:**
N.Israel:	F=0.891	Sig=0.412	F=0.491	Sig=0.612	F=**2.765**; Sig=0.064	F=0.997; Sig=0.370

In Northern Israel the electronic industry also comprises the biggest plants. Nevertheless, in the central region of Haifa 50 percent of the firms employ not more than 28 employees, even less than in Karlsruhe. Some very large firms raise the average size to 131 employees. For plastics, the most common prevalent plant size is around 70 employees in Eastern Galilee. According to the insignificant F-values both for industry and location, no explicit centre-periphery dichotomy exists in the average plant size of fast growing industries within Northern Israel. The decrease in average plant size from the metropolitan area to the periphery in Israel (for mean, but not for median) is the major characteristic in which the two samples differ; this difference is significant at the 10 percent level (F = 2.765). With respect to industry type the analysis of variance reveals only insignificant dissimilarities between the two countries.

3.3 Highly-skilled labour

Fast growing industries are generally associated with innovative activity, a larger knowledge base than slow growing industries, and a high demand for skilled labour (Shefer *et al.* 1998). Since the access to a large pool of skilled labour is especially fulfilled in metropolitan regions (Hassink 1997; Lyons 1995; Malecki 1985), it can be hypothesized that fast growing firms generally favour central locations. Localisation and urbanisation economies guarantee close access to a broad spectrum of labour skills (Meyer and Muheim 1996; Malecki 1991) and as a result of these advantages firms show a high locational persistence (David and Rosenbloom 1990). On the other hand there is also empirical evidence that growth in firms can also be generated in an unfavourable regional environment (Vaessen and Keeble 1995; Davelaar and Nijkamp 1988).

Table 4: Highly-skilled labour by industrial branch and location

(Employees with university or technical college degree 1995)

Location	Distribution measure	Electronics		Plastics		Metal		Total	
		Baden	N.Israel	Baden	N.Israel	Baden	N.Israel	Baden	N.Israel
Central	Mean	18.5	66.5	2.0	12.1	3.6	6.8	8.5	41.7
	Median	5.0	7.0	1.0	2.0	0.0	4.0	2.0	5.0
Intermediate	Mean	33.1	21.3	5.4	4.3	7.8	5.9	21.9	11.9
	Median	4.0	10.0	1.0	3.0	1.0	4.0	2.0	5.0
Periphery	Mean	14.1	10.6	1.0	5.1	1.6	6.3	6.8	6.7
	Median	3.5	7.0	1.0	5.0	1.0	6.0	1.0	5.5
Total	Mean	21.6	36.2	2.6	6.3	3.3	6.3	11.4	18.7
	Median	4.0	8.0	1.0	3.0	1.0	4.3	2.0	5.0

ANOVA results:

	Location:		Industry:		Cross-Country: 2-Way	
Baden:	F=0.859	Sig=0.425	**F=5.648**	Sig=0.004	**Country-Location:**	**Country-Industry:**
N.Israel:	F=1.609	Sig=0.203	**F=3.597**	Sig=0.029	F=1.664; Sig=0.191	F=0.271; Sig=0.763

Using the number of employees with a higher level of education as an indicator for highly-skilled labour, the figures presented in Table 4 reveal a higher knowledge-intensity in central locations. The average industrial plant in the central region of Haifa employs 41.7 highly-skilled labourers, while in the periphery only 6.7 employees with higher education can be found in a plant. Despite the fact that the average peripheral firm is smaller than those in the metropolitan region, the share of highly-skilled labour is also lower on the periphery. On the other hand, nearly similar medians in all three regions can be found, giving a slight advantage to the periphery

(5.5 employees). For this reason the analysis of variance allows no indication for significant interregional disparities (F value for location = 1.609). The strongest contribution to the high mean in the central region is made by the electronic industry. It employs 66.5 highly qualified people on average which makes this branch highly dependent on highly-skilled labour. In the plastics as well as the metal industry the demand for highly-skilled and well educated employees seems to be much lower as the similar means of 6.3 and the fairly equal distribution between the three regions suggest. This unequal distribution among the branches is reflected by an F-value of 3.597, which is significant at the 5 percent level.

In Baden it is again the intermediate region which comprises the largest number of highly-skilled employees per plant, mainly because of the labour demand in the electronic industry. Comparing the absolute figures in Table 4 with the average firm size in the regions (see Table 3), the highest skill-intensity can be found in the central region. Especially in electronic firms, but also in the other industrial branches the share of highly-skilled labour is greater in the central region of Karlsruhe than in the two other regions. According to the ANOVA results based on the absolute number of highly-skilled employees, there is no statistical evidence for supporting the hypothesis that in Baden high-skill intensive industries prefer central locations (insignificant F-value for location: 0.859). On the other hand, branch differences are significant at the 1 percent level (F = 5.648).

Comparing both Baden and Northern Israel it is interesting to see that in Baden the intensity of highly-skilled labour is lower than in Northern Israel (11.4 vs. 18.7 employees with higher education). The major reason for this difference can be attributed to labour costs which are higher in Germany than in Israel, especially with respect to highly-skilled labour, so that German firms reduce employment as much as possible and substitute labour by capital, where possible (Franz 1994). These substitution effects are in part responsible for the increase in German unemployment rates, also among highly-skilled employees, in recent years. Nevertheless, cross-country differences are not as strong as to be statistically significant.

3.4 Turnover

The turnover of a firm is not only a measure of size, but also an indicator for economic power and influence (e.g. by tax contributions). Compared to the average employment figures, a similar spatial distribution within Baden and Northern Israel can be found for average turnover. In Baden, highest average turnover is generated

by fast growing firms in the intermediate region (18.15 m US $), followed by plants located in the peripheral area. Corresdonding to their small employment size the average turnover of firms located in the central area is about three times less than that of plants located in the intermediate region. The F-value of the analysis of variance according to location (Table 5) is not statistically significant. On the other hand, differences are obvious between the branches, although significant only at the 10 percent level, where the highest average turnover is reached by the electronic industry (20.81 m US $).

Table 5: Average turnover of plants by industrial branch and location
(in million $ 1995)

Location	Distribution measure	Electronics		Plastics		Metal		Total	
		Baden	N.Israel	Baden	N.Israel	Baden	N.Israel	Baden	N.Israel
Central	Mean	6.68	19.48	4.00	27.46	5.62	16.00	5.63	20.04
	Median	3.39	1.70	3.67	1.75	1.91	4.50	2.65	2.00
Intermediate	Mean	25.00	13.69	2.98	11.27	10.64	5.59	18.15	11.24
	Median	7.40	5.96	2.41	6.00	3.21	3.40	3.64	5.00
Periphery	Mean	22.91	4.80	5.04	7.86	4.78	7.49	12.56	7.00
	Median	3.76	2.85	4.47	6.00	2.47	5.20	2.90	5.10
Total	Mean	20.81	13.73	4.00	12.57	6.16	9.86	12.53	12.52
	Median	3.70	2.98	3.05	5.50	2.41	4.00	3.30	4.50

ANOVA results:

	Location:		Industry:		Cross-Country: 2-Way	
Baden:	F=0.564	Sig=0.570	F=**2.866**	Sig=0.059	**Country-Location:**	**Country-Industry:**
N.Israel:	F=**2.967**	Sig=0.054	F=0.447	Sig=0.640	F=**2.759**; Sig=0.064	F=1.703; Sig=0.183

While in Baden the electronic industry is by far the largest industrial branch, in Northern Israel plants from the electronic and plastic industry have a similar average turnover volume. Therefore the turnover distribution among industrial branches is fairly equal and differences are statistically insignificant, reflected by the low F-values for industry in the analysis of variance. With respect to regional disparities the already observed decrease in the average plant size can also be observed for turnover, although, as was the case with employment, the median indicates an increase towards the periphery (see „total" column in Table 5). Despite some large firms in the central region of Haifa (especially in plastics, but also in electronics), 50 percent of the plants barely reach a turnover of 2 m US$ there. This is the result of

the removal of production facilities to intermediate and peripheral areas, leaving smaller plants with a stronger orientation towards R&D in the central area.

The comparison between age, employment and turnover points to the existence of at least two locational structures in Northern Israel. On the one hand Eastern Galilee with well established, mainly smaller plastic and metal firms (and fewer electronic firms). These mostly low-tech industries (Shefer *et al.* 1998) are not affected so much by agglomeration economies. On the other hand, two closely interacting central and intermediate regions in which a few large plants, mainly from the plastic industry, to a minor extent also from the electronics and metal industry, are still located in the urban region of Haifa. Here they utilize agglomeration advantages (Shefer and Frenkel 1998). Nevertheless, emerging urban diseconomies push other firms to the surrounding intermediate region which by itself generates positive external effects and attracts new and young fast growing firms, yet still having the advantage of being located in close proximity to Haifa. For the regions in Baden, no such pattern can be found. Therefore it is the locational structure in which the two country samples differ (significant at the 10 percent level), while industrial branch differences are insignificant in the cross-country comparison (Table 5).

In Northern Israel this decentralisation process is supported by the establishment of new branch-plants in the intermediate region. According to Table 6 the share of branch plants is highest in the intermediate zone (28 %), while it is less in the central and especially in the peripheral region. The data unfortunately does not reveal whether the branch plants are founded as a result of a production shift either from the central or the peripheral region or whther they result from the growth of firms already located in the intermediate zone. Nevertheless, the low branch plant share of 7.9 percent on the periphery points to the fact that peripheral industrialisation in Israel is not linked to a temporaly production shift from other regions, but to endogeneous economic potentials, mainly due to industrial activities of the *kibbutzim* which are particularly engaged in plastic production. In Baden, the share of branch plants is low in all three regions, indicating high firm autonomy, independent of the type of region in which a firm is located.

Table 6: Distribution of plants by ownership type and location

Type of region	Single Firm		Branch Plant	
	Baden n = 207	N. Israel n = 169	Baden n = 12	N.Israel n = 42
Central	92.6	78.8	7.4	21.2
Intermediate	94.9	72.0	5.1	28.0
Periphery	95.3	92.1	4.7	7.9
Total	94.5	80.1	5.5	19.9

3.5 Input for Research and Development

Within the spectrum of indicators representing different aspects in the innovation process (Grupp 1998), the personnel engaged in R&D activities and the expenditure on R&D are often used as indicators for analysing the employment and human capital investment of a firm in innovation (Eurostat 1995). On a regional or sectoral aggregation level these input indicators give at least a rough impression of the level of innovative activity.

Table 7 exhibits the average number of R&D employees by industrial branch and location. As for skilled labour, Israeli plants employ more workers in R&D (14.8) than their counterparts in Baden (8.6). Compared with the average firm size these figures would suggest a higher R&D intensity of the Israeli firms. That this view is an oversimplification can be seen from Table 8 according to which Baden firms invest on average more money in R&D (2.04 m US$) than Israeli plants (1.56 m US$), despite a similar average turnover. Again, the substitution of labour by capital in Germany holds true for the organisation of R&D processes as well.

Both for R&D personnel and expenditures the average figures presented in Tables 7 and 8 indicate a decrease in R&D activity from the central region towards the periphery in Northern Israel, however this distribution pattern is statistically insignificant. Especially R&D activity in the electronic industry is located mainly in the central area. High R&D inputs in the central region are contrasted by substantially lower inputs of R&D in the intermediate and peripheral areas. The electronics industry seems to be strongly affected by agglomeration effects in research and development. These disparities are much more pronounced than for the other two industrial branches for which only minor inter-area differences can be identified on a much lower R&D input intensity. For this reason the results of the analysis of variance for Northern Israel were not found to be statistically significant with respect to both

employees and expenditure in R&D. Interbranch differences are evident for the number of R&D employees, although this deviation is significant at the 10 percent level only. The lower R&D input in the plastics and metal industry illustrates that fast growth should not automatically be associated with high R&D activities.

Table 7: Average numbers of employees in R&D by industrial branch and location

(Employees in R&D 1995)

Location	Distribution measure	Electronics		Plastics		Metal		Total	
		Baden	N.Israel	Baden	N.Israel	Baden	N.Israel	Baden	N.Israel
Central	Mean	11.1	51.5	0.8	3.4	1.7	5.0	4.7	37.7
	Median	6.0	7.0	1.0	1.0	0.0	2.0	1.0	6.0
Intermediate	Mean	22.8	13.9	20.5	2.8	2.8	5.1	16.2	8.1
	Median	3.5	10.0	0.5	2.0	1.0	3.0	2.0	4.0
Periphery	Mean	13.0	5.9	0.7	2.8	1.1	2.3	6.2	3.6
	Median	3.0	6.0	0.2	2.0	0.0	2.5	1.0	3.0
Total	Mean	15.9	28.2	6.3	3.1	1.6	4.4	8.6	14.8
	Median	4.0	8.0	0.5	2.0	0.5	2.5	1.0	4.0

ANOVA results:

	Location:		Industry:		Cross-Country: 2-Way	
Baden:	**F=2.758**	Sig=0.066	**F=6.133**	Sig=0.003	**Country-Location:**	**Country-Industry:**
N.Israel:	F=0.822	Sig=0.442	**F=2.388**	Sig=0.096	F=1.976; Sig=0.140	F=0.593; Sig=0.553

Table 8: Average expenditure on R&D by industrial branch and location

(in million $ 1995)

Location	Distribution measure	Electronics		Plastics		Metal		Total	
		Baden	N.Israel	Baden	N.Israel	Baden	N.Israel	Baden	N.Israel
Central	Mean	1.12	5.70	0.48	0.30	0.22	0.66	0.71	4.29
	Median	0.49	0.50	0.23	0.20	0.13	0.10	0.26	0.25
Intermediate	Mean	5.97	0.99	0.13	0.28	1.41	0.37	4.31	0.66
	Median	0.60	0.75	0.13	0.18	0.16	0.18	0.47	0.25
Periphery	Mean	1.93	0.27	0.14	0.18	0.29	0.24	1.18	0.21
	Median	0.65	0.18	0.11	0.18	0.18	0.16	0.28	0.18
Total	Mean	3.21	2.84	0.23	0.23	0.51	0.40	2.04	1.56
	Median	0.57	0.45	0.12	0.18	0.16	0.15	0.27	0.20

ANOVA results:

	Location:		Industry:		Cross-Country: 2-Way	
Baden:	F=0.468	Sig=0.628	F=1.545	Sig=0.218	**Country-Location:**	**Country-Industry:**
N.Israel:	F=0.667	Sig=0.515	F=1.250	Sig=0.293	F=0.800; Sig=0.450	F=0.042; Sig=0.959

In Baden it is again the intermediate zone where firms with the highest absolute R&D input are located. This high input corresponds to the much larger average firm size there (employment, turnover), compared to the smaller average plant size in the central area of Karlsruhe. Bearing this size distribution in mind, the lowest R&D-input can be found in the periphery. Here plants are only slightly smaller compared to the intermediate region, but employ much less R&D personnel and have lower R&D expenditures. In the electronics industry, plants in Karlsruhe reach only less than a third of the size of plants located in the intermediate region (both for employment and turnover; cf. Tables 3 and 4), but employ on average half as many people in R&D as the Freiburg firms. This makes the central area a R&D-personnel intensive location for the electronics industry. With respect to R&D expenditures, no such clear picture is evident. A similar pattern has already been identified by using highly-skilled labour as an indicator for the knowledge-intensity of the plants. Firms from the plastic and metal industry are on average far less R&D-intensive than the electronic plants. For them, a declining R&D-intensity towards the periphery can also be recorded. Therefore, the results for Baden also support the close association between agglomeration and R&D-intensive firms, especially in the electronic industry.

While R&D employees in Baden are fairly unequally distributed among the industrial branches and locations (both F-values for location and industrial branches are statistically significant), differences with respect to R&D expenditure are minimal and therefore statistically insignificant. Additionally, strong dissimilarities between the two country samples cannot be found (no statistically significant F-values were obtained for the comparision between the countries). For Israel and Baden the results support the preference of electronic plants for central locations in both countries.

3.6 Innovative activity

As already pointed out, fast industrial growth is generally associated with innovative activity. Using R&D indicators, this assessment has especially been verified for the electronic industry in our sample. In the following two tables, another classification approach is used for the distinction between innovative and non-innovative fast growing industrial branches. Innovative firms are defined as those firms that have created innovations during the three year's period 1993-1995. Included in this definition are activities leading to the development of new products, the adoption of products, which are new to the market, and the substantial improvement of existing

products (development of the next generation of products). These activities emanate from in-house investments in R&D, or 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 as innovative firms. According to this definition, around 57 percent of the firms of the total sample belong to the group of innovative firms, while nearly 43 percent of the fast growing industries are non-innovative. This is an indication for the fact that industrial growth can also be realised without engagement in product innovation, although process and organisational innovation might still be possible and could contribute to the above average industrial growth. As can be seen from Table 9, the share of innovative firms is higher in Northern Israel (59.7 %) than in Baden (54.6 %). With respect to the regional breakdown in the two case study areas, Baden's central and especially the intermediate area comprise an above average share of innovative firms (54.9 % respectively 65.5 %), whereas in the periphery slightly more non-innovative than innovative firms can be found (51.5 %). In Northern Israel it is the central region which hosts the highest share of innovative plants (65.2 %), followed by the periphery (60.3 %). In the intermediate area, also more innovative than non-innovative firms are located (54.9 %), although the share of innovative firms is below the Northern Israelian average (59.7 %).

Table 9: Distribution of Fast Growing Industries by Innovation and Location
(in %)

	Baden				Northern Israel			
Innovation	Central	Intermediate	Periphery	Total	Central	Intermediate	Periphery	Total
Innovative firms	54.9	65.5	48.5	54.6	65.2	54.9	60.3	59.7
Non-Innovative firms	45.1	34.5	51.5	45.4	34.8	45.1	39.7	40.3
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
N	51	55	101	207	66	82	63	211

At least for Baden's intermediate region the spatial distribution of innovative and non-innovative confirms the already derived picture of a highly innovative region, while innovative activity, measured by the share of innovating firms, in the central and peripheral areas is lower. In Northern Israel, on the other hand, it is the intermediate region in which the lowest share of innovative, fast growing industrial plants are located. Although industrial growth is possible without product innovation, also

this study shows the importance of R&D as a major factor in inducing innovation. According to the results presented in Table 10, there is a statistically significant relationship between the percentage of innovative firms and the firm's R&D activities, expressed by the number of R&D employees. For both Baden and Northern Israel the share of innovative firms increases with the number of R&D employees (highly significant according to $\lambda 2$-test). While in Baden all firms with 10 or more persons engaged in R&D activity are innovative, in Northern Israel only 5 % of the firms with 10 or more R&D employees are non-innovative. Compared to Northern Israel, the R&D activity in innovative firms in Baden seems to be based more on outsourced R&D services, and less on in-house R&D activity, as reflected in the number of R&D employees in the firm. In Germany, 10.9 % of all innovative firms employ no R&D personnel at all, compared with only 2.4 % in Israel. This result underlines again the different R&D strategies applied by the fast growing firms in the two countries with respect to the amount of personnel engaged in R&D activities.

Table 10: Distribution of Fast Growing Industries by Innovation and Number of R%D Employees in Baden and Northern Israel (in %)

	Baden				Northern Israel			
Number of R&D employees	0	1-4	5-9	10+	0	1-4	5-9	10+
Innovative firms	15.8	67.1	92.3	100.0	4.5	77.9	89.3	94.7
Non-innovative firms	84.2	32.9	7.7	0.0	95.5	22.1	10.7	5.3
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
N	76	73	13	37	66	77	28	38
λ^2	89.23				123.3			
P	0.000				0.000			

4. Conclusions for regional innovation policy

By analysing the regional distribution of plants from the fast growing industries in Baden and Northern Israel it was possible to obtain some insights into the locational preferences of these firms. The results of the analysis might be of some relevance for reducing interregional imbalances in economic activity and for supporting lagging regions. Despite the fact that according to location theory and the expected impact of dynamic agglomeration economies on the locational behaviour of industry (McCann 1995; Porter 1996), fast growing industries should favour metropolitan

regions, in both samples a general centre-periphery dichotomy is not evident. Although regional variations in firm age, size, highly-skilled labour, R&D input and innovative activity affect all three types of area, in most cases they are statistically insignificant. Nevertheless, the analyses made it clear that high R&D-intensity is more linked to central areas than to the periphery while plants spending less on research and development have higher shares among all fast growing industries in the intermediate and peripheral areas. This distribution is more pronounced in Northern Israel than in Baden where electronics is an important R&D-intensive industrial branch in the intermediate region. Transferring the assumptions of the product life-cycle hypothesis to the assumed technology-intensity of industrial branches, its prediction of the spatial distribution of highly-skilled labour and R&D-intensive production favouring central locations is supported by this analysis, especially for the Israeli case. On the other hand, this should not lead to the conclusion that fast growing firms located outside the metropolitan area are less innovative. There is ample empirical evidence that firms which do not have close access to a large pool of skilled labour compensate for this by employing adjusted innovation strategies, e.g. by substituting skilled labour by capital (Meyer-Krahmer et al. 1984; Meyer-Krahmer 1985; Pfirrmann 1991). These innovation strategies can especially be applied for firms in Baden which employ much less R&D personnel than the firms in Northern Israel, and for firms located in Baden's peripheral area where the majority of all fast growing plants of the sample are located.

What can be learned from this comparison between Baden and Northern Israel regarding regional policy and the objective of strengthening regional economic and innovation capabilities in non-metropolitan regions? The already mentioned decentralisation of industrial activity from the centre towards the intermediate zone in Northern Israel and the regional distribution of fast growing plants in Baden make it clear that these industries can be, under certain circumstances, an important target group for regional innovation policy. Fast growing industrial branches in particular which do not rely strongly on proximity to metropolitan areas in order to realise external effects by having access to university and other R&D labs or a well developed urban labour market can significantly contribute to employment and income outside the industrial and economic cores. Nevertheless, proximity to the central area, as is the case for the intermediate zone in Israel, well developed transportation and communication networks, the availability of industrial sites and a qualified labour force are supportive factors for fostering the decentralisation process. Therefore this kind of industrial decentralisation can be expected especially in spatial systems in which

the intermediate or peripheral areas possess endogeneous development and cultural potential equipping them for economic development independently from the central region. In Baden this is the case for both the intermediate and peripheral region which have long traditions as industry and service locations and in which vocational training and skills in the handling of small parts (e.g. watch-making industry in Schwarzwald-Baar-Heuberg) supported the establishment of a common cultural base and by this fostered industrial development and diversification. In Northern Israel, it is the peripheral area which originally served as an agricultural settlement region for the kibbutzim. These are not only engaged in agricultural production, but attracted many immigrants from different countries and diversified their economic activities to industrial production, e.g. the manufacturing of plastic products. Due to employment and income opportunities in the periphery, neither in Baden nor in Northern Israel has the connection of remote places to urban infrastructure facilities lead to centripetal counter effects and to an increase in regional disparities. On the contrary, the already developed economic base of the periphery made decentralisation possible, especially for those fast growing industrial branches which can compensate for a less innovative regional environment by drawing on an educated workforce present in this type of region.

To summarize, two important conclusions can be drawn from the empirical analysis in Baden and Northern Israel:

(1) Under the conditions of a peripheral economy fast industrial growth is also possible, especially for less R&D-intensive plants and branches which do not rely heavily on close links to an urban knowledge base.

(2) Decentralisation of fast growing industries to intermediate and peripheral areas will be favoured by an already existing endogeneous production system in these regions. It not only supports learning and knowledge creation within the regional labour force, but also generates conditions for the foundation of fast growing production facilities in the peripheral or intermediate zone itself.

Both the experiences of Baden's periphery and Israel's Northern region lead to the conclusion that above average industrial growth and peripheral development are not a contradiction, but an important condition for utilising endogeneous economic potentials already developed during previous agricultural and industrial activity. This precondition might not apply to every peripheral region, but to those in which infrastructural and human capital development are important objectives in regional eco-

nomic policy. The fact that this is a widely accepted policy aim in learning economies, increases the probability of a successful contribution of fast growing industries to interregional decentralisation in other countries as well.

References

Armstrong, H., Taylor, J., 1993, *Regional Economics and Policy.* Second edition. New York: Harvester Wheatsheaf.

Arrow, K.J., 1962, The Economic Implications of Learning by Doing, *Review of Economics Studies* 29, 155-173.

Braczyk, H.-J., Schienstock, G., Steffensen, B., 1995, The Region of Baden-Württemberg: a Post Fordist Success Story?, in: E.J. Dittrich, G. Schmidt, R. Whitley (Editors), *Industrial Transformation in Europe. Process and Contexts* (London: SAGE Publications) pp. 203-233.

Cooke, P., Morgan, K., 1994, The regional innovation system in Baden-Württemberg, *International Journal of Technology Management* 9, 394-429.

Cooke, P., Morgan, K., Price, A., 1993, *The Future of the Mittelstand. Collaboration versus Competition.* Cardiff: University of Wales.

Davelaar, E.J., 1991, *Regional Economic Analysis of Innovation and Incubation.* Worcester: Billing&Sons.

Davelaar, E.J, Nijkamp, P., 1997, Spatial Dispersion of Technological Innovation, in: C.S. Bertuglia, S. Lombardo, P. Nijkamp (Editors), *Innovative Behaviour in Space and Time*, (Berlin: Springer) pp. 17-40.

Davelaar, E.J., Nijkamp, P., 1988, The Urban Incubator Hypothesis: Re-Vitalization of Metropolitan Areas?, *The Annals of Regional Science* 22, 48-65 (special issue).

David, P., Rosenbloom, J.L., 1990, Marshallian Factor Market Externalities and the Dynamics of Industrial Location, *Journal of Urban Economics* 28, 349-370.

Dosi, G., 1988, Sources, Procedures, and Microeconomic Effects of Innovation, *Journal of Economic Literature* 26, 1120-1171.

Duijn, J.J.v., 1983, Fluctuations in Innovations over Time, in: C. Freeman (Editor), *Long Waves in the World Economy*,(London: Frances Pinter) pp. 19-30.

Eliot Hurst, M.E., 1973, *A Geography of Economic Behavior: An Introduction.* London: Duxbury Press

Eurostat, 1996, The Regional Dimension of R&D and Innovation Statistics - *Regional Manual* -. Draft. Luxembourg: Eurostat.

Feldman, M.P., 1993, *An Examination of the Geography of Innovation, Industrial and Corporate Change* 2, 451-470.

Feldman, M.P., Florida, R., 1994, The Geographic Sources of Innovation: Technological Infrastructure and Product Innovation in the United States, *Annals of the Association of American Geographers* 84, 210-229.

Feldman, M.P., Kutay, A.S., 1997, Innovation and Strategy in Space: Towards a New Location Theory of the Firm, in: C.S. Bertuglia, S. Lombardo, P. Nijkamp (Editors), *Innovative Behaviour in Space and Time* (Berlin: Springer) pp. 239-250.

Franz, W., 1994, Säkulare Unterbeschäftigung: Ist die Zwei-Drittel-Gesellschaft noch zu vermeiden?, in: Alfred-Herrhausen-Gesellschaft für internationalen Dialog (Editor), *Arbeit der Zukunft - Zukunft der Arbeit* (Stuttgart: Schäffer-Poeschel Verlag) pp. 57-78.

Freeman, C., 1991, Networks of innovators: A synthesis of research issues, *Research Policy* 20, 499-514.

Frenkel, A., 1997, Can Regional Policy Affect Firms' Innovation Potential in Lagging Regions? Paper presented to the 37th European Congress of the Regional Science Association, Rome, Italy, 26-29 August.

Frenkel, A., Shefer, D., Koschatzky, K., Walter, G.H., 1997, Regional Innovation Profiles of Firms in Fast-Growing Industries: A German-Israel Comparison, in: The S. Neaman Institute, MIT Enterprise Forum of Israel (Editors), *Innovation: Technology Assessment, Forecasting, Strategy and Regional Policy* (Haifa: S. Neaman Institute) pp. 43-72.

Geroski, P., Machin, S., 1992, Do Innovating Firms Outperform Non-Innovators?, *Business Strategy Review*, 79-81.

Grossman, G.M., Helpman, E., 1991, *Innovation and Growth in the Global Economy*. Cambridge, MA: MIT Press

Grossman, G.M., Helpman, E., 1990, Comparative Advantage and Long-Run Growth, *The American Economic Review* 80, 796-815.

Grupp, H., 1998, *Foundations of the Economics of Innovation. Theory, Measurement and Practice*. Cheltenham: Edward Elgar

Grupp, H., Schmoch, U., Koschatzky, K., 1998, Science and Technology Infrastructure in Baden-Württemberg and Its Orientation towards Future Regional Development, *Journal of the American Society for Information Science* 49, 18-29.

Hampe, J., Koll, R., 1989, Regionale Entwicklung und langfristiger Wandel der Arbeitsteilung: Theoretische Zusammenhänge und empirische Analyse am Beispiel der langfristigen Entwicklung ausgewählter Sektoren in Bayern, in: E.v. Böventer (Editor), *Regionale Beschäftigung und Technologieentwicklung* (Berlin: Duncker & Humblot) pp. 39-80.

Hassink, R., 1997, *What distinguishes 'good' from 'bad' industrial agglomerations?*, Erdkunde 51, 2-11.

Hoover, E.M., Vernon, R., 1959, *Anatomy of Metropolis*. Cambridge: Harvard University Press

Isard, W., 1956, *Location and Space-Economy. A General Theory Relating to Industrial Location, Market Areas, Land Use, Trade and Urban Structure*. Cambridge, MA: MIT Press

Jaffe, A.B., Trajtenberg, M., Henderson, R., 1993, Geographic Localization of Knowledge Spillovers as evident by Patent Citations, *The Quarterly Journal of Economics* 108, 577-598.

Kleinknecht, A., 1996, *Determinants of Innovation. London*: Macmillan Press.

Kline, S.J., Rosenberg, N., 1986, An Overview of Innovation, in: R. Landau, N. Rosenberg (Editors), *The Positive Sum Strategy. Harnessing Technology for Economic Growth* (Washington: National Academy Press) pp. 275-305.

Koschatzky, K., 1997, *Innovationsdeterminanten im internationalen Vergleich: Möglichkeiten zur Stärkung regionaler Innovationspotentiale,* Geographische Zeitschrift 25, 97-112.

Koschatzky, K., 1999, Innovation Networks of Industry and Business-Related Services – Relations between Innovation Intensity of Firms and Regional Inter-Firm Co-operation, Paper accepted for publication in *European Planning Studies* 7.

Krauss, G., 1996, Innovation and Restructuring in Baden-Württemberg, in: A. Kuklinski (Editor), *Production of Knowledge and the Dignity of Science* (Warsaw: University of Warsaw) pp. 96-113.

Krugman, P., 1995, Development, *Geography and Economic Theory*. Cambridge: MIT Press.

Lloyd, P., Dicken, P., 1972, *Location in Space. A Theoretical Approach to Economic Geography*. New York: Harper Row.

Lucas, R.E., 1988, On the Mechanics of Economic Development, *Journal of Monetary Economics* 22, 3-42.

Lyons, D., 1995, Agglomeration Economies among High Technology Firms in Advanced Production Areas: The Case of Denver/Boulder, *Regional Studies* 29, 265-278.

Malecki, E.J., 1991, *Technology and economic development: the dynamics of local, regional, and national change*. New York: Longman.

Malecki, E.J., 1985, Industrial location and corporate organization in high technology industries, *Economic Geography* 61, 345-369.

McCann, P., 1995, Rethinking the Economics of Location and Agglomeration, *Urban Studies* 32, 563-577.

Meyer, H.v., Muheim, P., 1996, Employment is a Territorial Issue, *The OECD Observer* 19, 22-26.

Meyer-Krahmer, F., 1985, Innovation Behaviour and Regional Indigenous Potential, *Regional Studies* 19, 523-534.

Meyer-Krahmer, F., Dittschar-Bischoff, R., Gundrum, U., Kuntze, U., 1984, *Erfassung regionaler Innovationsdefizite, Schriftenreihe 06 Raumordnung*, 06.054. Bonn: Bundesminister für Raumordnung, Bauwesen und Städtebau

Nelson, R., Winter, S.G., 1982, *An Evolutionary Theory of Economic Change*. Cambridge, Mass: Harvard University Press

Oakey, R.P., 1984, Innovation and Regional Growth in Small High Technology Firms: Evidence from Britain and the USA, *Regional Studies* 18, 237-251.

Pfirrmann, O., 1991, Innovation und regionale Entwicklung. Eine empirische Analyse der Forschungs-, Entwicklungs- und Innovationstätigkeit kleiner und mittlerer Unternehmen in *den Regionen der Bundesrepublik Deutschland* 1978-1984. Munich: VVF.

Porter, M.E., 1996, Competitive Advantage, Agglomeration Economies, and Regional Policy, *International Regional Science Review* 19, 85-94.

Porter, M.E., 1990, *The Competitive Advantage of Nations*. London: Macmillan.

Romer, P.M., 1987, Growth Based on Increasing returns Due to Specialization, *The American Economic Review* 77, 56-62.

Romer, P.M., 1986, Increasing Returns and Long-Run Growth, *The Journal of Political Economy* 94, 1002-1037.

Saxenian, A., 1990, Regional Networks and the Resurgence of Silicon Valley, *California Management Review* 33, 89-112.

Schätzl, L., 1996, Wirtschaftsgeographie 1. *Theorie. Sixth edition*. Paderborn: Schöningh.

Semlinger, K., 1993, Economic development and industrial policy in Baden-Württemberg: Small firms in a benevolent environment, *European Planning Studies* 1, 435-464.

Shefer, D., Frenkel, A., 1998, Local Milieu and Innovations: Some Empirical Results, *The Annals of Regional Science* 32, 185-202.

Shefer, D., Frenkel, A., Koschatzky, K., Walter G.H., 1998, Targeting Industries for Regional Development in Israel and in Germany - A Comparative Study, Paper accepted for publication in *Environment and Planning C: Government and Policy*.

Simmie, J., 1997, Origins, Structure and Contents, in J.Simmie (Editor), *Innovation, Networks and Learning Regions* (London: Jessica Kingsley Publ.) pp. 3-9.

Statistisches Landesamt Baden-Württemberg, 1997, *Statistisches Taschenbuch* 1997. Stuttgart: Metzler-Poeschel.

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

Suarez-Villa, L., 1993, The Dynamics of Regional Invention and Innovation: Innovative Capacity and Regional Changes in the Twentieth Century, *Geographical Analysis* 25, 147-164.

Tichy, G., 1991, The product-cycle revisited: Some extensions and clarifications, *Zeitschrift für Wirtschafts- und Sozialwissenschaften* 111, 27-54.

Vaessen, P., Keeble, D., 1995, Growth-oriented SMEs in Unfavourable Regional Environments, *Regional Studies* 29, 489-505.

Vernon, R., 1960, *Metropolis* 1985. Cambridge: Harvard University Press.

Walter, G.H., 1997, Emergence and Development of Regional Technology Policy in Germany - The TechnologieRegion Karlsruhe, in: The S. Neaman Institute, MIT Enterprise Forum of Israel (Editors), *Innovation: Technology Assessment, Forecasting, Strategy and Regional Policy* (Haifa: S. Neaman Institute) pp. 73-87.

Appendix C

Regional Concentration and Dynamics of Fast Growing Industries in Baden-Württemberg and Israel

Knut Koschatzky*, Amnon Frenkel, Guenter H. Walter*, Daniel Shefer****

Submitted to *International Planning Study*

* Fraunhofer Institute for Systems and Innovation Research, Karlsruhe, Germany.

** S. Neaman Institute for Advanced Studies in Science and Technology, Technion - Israel Institute of Technology, Haifa, Israel.

Abstract

Fast growing industries are regarded as providing an above average contribution to production, employment and innovation. Due to necessary knowledge slipovers and a high product innovation rate, these industries are expected to have a locational bias towards central, metropolitan regions offering a risk- and uncertainty-minimising industrial atmosphere. Using statistical data on the regional distribution and composition of fast growing industrial branches in Baden-Württemberg and Israel, it is the objective of this paper to analyse the spatial distribution of fast growing industries and to answer the question whether also non-metropolitan regions provide favourable location conditions which could be made the starting point for regional development strategies. Based on different methods of regional analysis, like concentration indices and shift-share analysis, our results indicate that although the highest share of fast growing industrial branches can still be found in central regions, spatial dispersion towards intermediate and peripheral regions occurred between the late 80s and early 90s in Baden-Württemberg as well as in Israel. This decentralisation process makes it clear that these industries can be an important target group for regional policy.

Key Words: fast growing industries, spatial dynamics, regional development, Baden-Württemberg, Israel

Introduction

Rapidly growing industries provide an above average contribution to production, employment generation, exports and innovation (DOSI *et al.*, 1990, ROSENBERG *et al.*, 1992). Thus these industries can be regarded as important producers and users of new production technology and therefore serve as focal points for the diffusion of new technologies. The existence of fast growing industries (FGIs) is not only an important factor for securing and strengthening national competitiveness, but also a significant element for regional development and convergence (KEEBLE, 1997; VAESSEN and KEEBLE, 1993). Innovative and advanced economic activities tend to possess a high market value, resulting in a competitive advantage at least during the first stage of the technology and product diffusion process. Regions equipped with high level innovation activities will show a great acceleration of economic growth (DAVELAAR and NIJKAMP, 1997; FELDMAN and KUTAY, 1997; LYONS, 1995). While in classical location theory the existence of urban agglomerations was explained by the positive effects of spatial proximity to related branches, sharing a common labour pool or specialised suppliers (localisation economies), or of spatial proximity to a diversified supply of urban activities, reducing transaction costs in general (urbanisation economies) (ISARD, 1956), recent interpretations of the theory of localisation apply a more evolutionary view in explaining spatial dynamics (STORPER, 1995). Agglomerations emerge not only because of their physical assets, but because of the specificity of localised knowledge related to breakthrough innovations. Although not all parts of this knowledge are spatially localised, its tacit character make regular interpersonal contacts necessary which strongly depend on spatial proximity. By transforming these generic assets into a specifically new industry, the region in which the knowledge was generated gets established as a new agglomeration (STORPER, 1997: 70). According to this evolutionary interpretation, core regions are subject to a permanent change and threat, depending on the ability of regional firms and institutions to constantly generate new specific, non-standardisable knowledge, and on the ability of firms and institutions in other regions either to imitate this knowledge or to generate specific knowledge by their own. Slipovers, diffusion and inter-industry linkages are important mechanisms for evolving new development trajectories. Since also non-core regions (i.e. intermediate or peripheral regions) are able to generate own growth conditions and to become a new core, a functional relationship exists between these different types of regions in a way that regional production systems are interdependently linked and that the industrial organisation of the core is influenced by organ-

isational developments outside the agglomeration (SCOTT, 1995; STORPER, 1997: 77). Regions are not regarded as a spatial entity per se (as they were in classical location theory), but are defined on the basis of the nature of contractual and institutional relations which by themselves define the organisation of the production system (CONTI, 1995: 72).

Another view of spatial dynamics is hold by some models of the new growth theory (e.g. ROMER, 1986, 1987; LUCAS, 1988; GROSSMAN and HELPMAN, 1990, 1991) and by the spatial version of the product life-cycle hypothesis (e.g. TICHY, 1991). Due to their higher propensity for knowledge slipovers (JAFFE *et al.*, 1993; FELDMAN and FLORIDA, 1994) and a high human capital intensity, fuelled by an urban pool of specialised and qualified labour, fast growing, innovative industries are expected to be mostly located in central, metropolitan regions. This holds especially true for the development and market introduction phase and the first growth phase of a new product or industry. In the following phases of the product life-cycle, the maturity and decline phases, knowledge diffusion, an increasing degree of standardisation in production and the resulting increase in capital intensity make it possible to shift the optimal production location from the centre to the periphery, resulting in intra-regional, interregional and international decentralisation processes (ARMSTRONG and TAYLOR, 1993; VAN DUIJN, 1984; HAMPE and KOLL, 1989; SCHÄTZL, 1996). According to this hypothesis, economic development in intermediate and peripheral regions strongly depends on industrial strategies of core firms. Nevertheless, as the results of several empirical studies indicate, different regions play unique and separate roles in innovation (DAVELAAR, 1991; OAKEY 1984) and the attributes of a region do not automatically influence the innovative behaviour of firms located there (KLEINKNECHT and POOT, 1992). Innovative activity is not only confined to metropolitan regions. Innovative, fast-growing SMEs can also be found in peripheral areas (OAKEY and COOPER, 1989; VAESSEN and KEEBLE, 1995), although the kind of innovation and the applied innovation strategies might differ from firms located in central regions, e.g. by substituting skilled labour by capital to handle the limited supply of skilled labour or by providing a better access to formal training (MEYER-KRAHMER, 1985; KOSCHATZKY, 1997a). Recent studies therefore also emphasise the importance of intermediate and peripheral regions as locations for growth-intensive firms (SIMMIE, 1997).

According to both theoretical views, agglomerations, be they explained statically or in an evolutionary context, provide favourable growth conditions for enterprises. Among others, firms can profit from slipover effects generated by both other firms and research institutes, they can make use of the concentrated regional demand as a test market for national or international market penetration, or they obtain access to production capabilities not available elsewhere (STORPER, 1997: 243). While traditional location and regional growth theory predicts spatial deconcentration only in the long run by possibly emerging urban diseconomies in the core region (FRIEDMANN, 1966), the recent debate on spatial dynamics argues that spatial entities are subject of an evolutionary change, depending on the specificy of localised knowledge and the ability of regions to reduce risks and transaction costs for innovators and producers.

Based on the evolutionary interpretation of spatial systems it is the objective of this paper to analyse the locational pattern of FGIs with respect to policy implications for the reduction of regional disparities by the utilisation of growth and innovation resources in less-developed, peripheral regions. Acknowledging the limited transferability of case study results, regional case studies are nevertheless helpful in deriving academic and policy lessons for the regions under investigation and in contributing empirical evidence to a general theoretical discussion. The question whether fast growing branches favour metropolitan central regions or whether the locational behaviour of these dynamic enterprises tend to increase the chance for spatial decentralisation should therefore be dealt with in a contrasting regional comparison. The fast growing economy Israel, on the one hand, is still characterised by a polarised spatial structure, but with emerging regional development potentials (SHEFER, 1993), mainly due to the large waves of immigrants who migrated to Israel since 1990 from the former Soviet Union and who settled not only in the large cities, but as well as in intermediate and peripheral regions (FRENKEL *et al.*, 1997). For supporting this decentralisation process regional policy makers are seeking for indications whether FGIs can be made the starting point for innovation-oriented regional policies (KOSCHATZKY, 1997b) and whether these firms can contribute to the generation of modern employment opportunities in non-metropolitan regions. This is especially relevant for those areas in Israel (e.g. the north) where the border is hermetically sealed to the neighbouring countries and where firms cannot profit from transborder interaction and slipovers. Baden-Württemberg, on the other hand, serves as reference for the Israeli case study because it is one of the federal states in Germany with quite a long history in an

explicit regionally oriented economic policy. It is characterised by a broad, medium-sized industrial structure and by large, internationally operating companies like Daimler-Benz, Porsche and Bosch. Major branches are machinery, electrical and electronic equipment, transport equipment, and metal products. The "Mittelstand" of Baden-Württemberg and innovation supporting institutions like Steinbeis transfer centres, Fraunhofer Institutes, universities, technical colleges and others are seen as important economic success factors in this federal state (BRACZYK et al., 1995; SEMLINGER, 1993; COOKE and MORGAN, 1994; HASSINK, 1996; KRAUSS, 1996). Although the two case study regions differ in size, their economic and political structure and in public infrastructure supply, it will nevertheless be interesting to analyse differences and similarities in spatial adjustment flexibilities based on the location pattern of fast growing industries and to derive regional policy conclusions about the contribution of FGIs for the spatial decentralisation of dynamic industrial branches.

Sectoral and Regional Composition of Data

Using official statistical data, for both Israel and Baden-Württemberg FGIs were identified out of 17 major industrial branches (two digit code of the Standard Industrial Classification) according to the following four criteria (cf. SHEFER *et al.*, 1997 for full description of the selection procedure):

(1) Change in industrial production.

(2) Change in the number of employees.

(3) Share of export in total turnover (revenue).

(4) Change in export share.

Additionally, research and development (R&D) indices like number of employees engaged in R&D, total expenditures of R&D and R&D intensity for specific branches were included in the selection of fast growing industries. Data availability made it necessary to confine the investigation to the period 1987 - 1993 for Israel and 1989 - 1994 for Baden-Württemberg. Different classification approaches like the comparison between growth rates in employment and production were used to identify those industrial branches which grew above average within these two periods. All those branches were excluded from the analysis where the growth could be attributed to temporarily country-specific shock-effects, i.e. the expansion of de-

mand due to Germany's unification and the effects caused by the influx of Russian immigrants in Israel: the food, wood, paper and printing industries in Germany and the non-metallic mineral products and the wood industries in Israel. For Baden-Württemberg, the following five branches were identified as growing above average: the chemical industry, the rubber and plastics industry, the machinery industry, the electric and electronic equipment industry, and the transport equipment industry.[1] For Israel, FGIs are: the rubber and plastics industry, the metal products industry, electric and electronic equipment industry, and the miscellaneous industries, i.e. precision, optical and photographic instruments. Although not the same branch aggregates are used in the Baden-Württemberg and the Israeli data, the target group is still those branches which contribute above average to production, employment and innovation. Nevertheless, in spite of the slight differences in branch definitions and the difference in the size of Baden-Württemberg and Israel (with respect to population, employment and number of sub-regions) only a rough comparison is possible.

It has to be pointed out that branches identified, as fast growing on the regional macro level (i.e. Baden-Württemberg and Israel), might not grow above average in every sub-region. According to the share of less dynamic sub-branches within each FGI category, below average growth rates can also be found. This is especially true for Baden-Württemberg where above average growth, at least in employment, is still attributed to negative growth rates (cf. Tab. 1), although the negative growth in FGIs is minor compared with other industries.

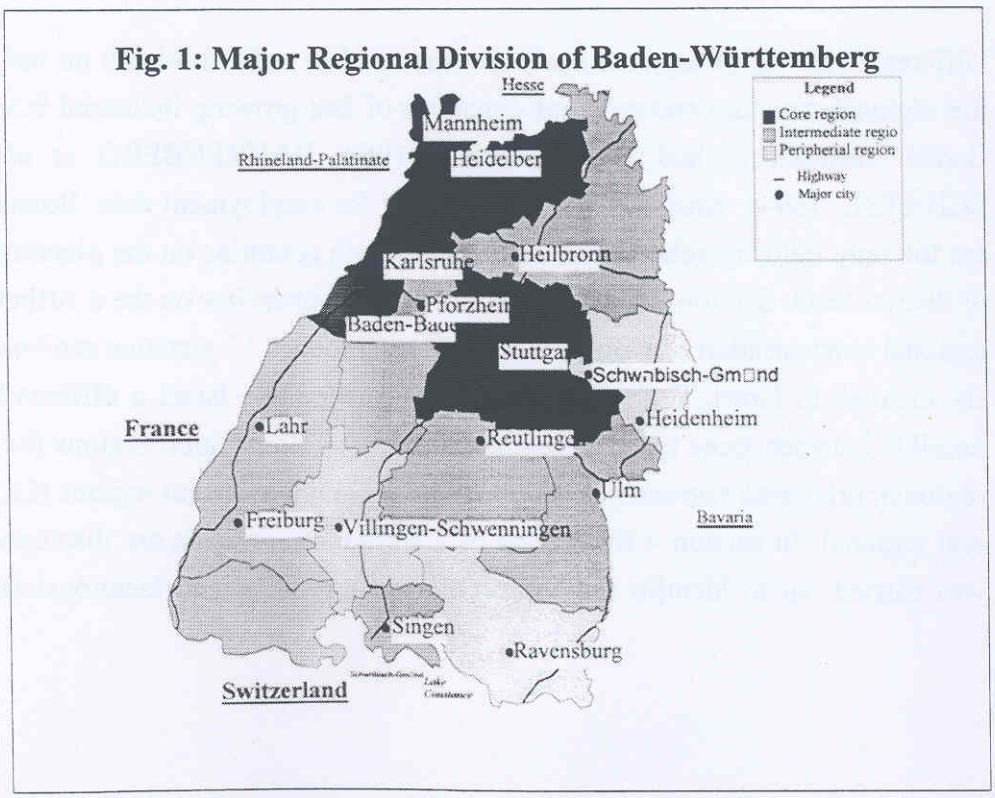
Different methods of regional analysis were used in order to obtain an insight into the regional structure and regional dynamics of fast growing industrial branches in Baden-Württemberg and Israel (ISARD, 1960; BAHRENBERG *et al.*, 1985, SCHÄTZL, 1994). Analyses were carried out for employment data, because these are the only industry-related data available in both countries on the planning region or district level. Section 3 of this paper provides an overview on the distribution and regional concentration of FGIs in Baden-Württemberg's 12 planning regions and the six districts in Israel. Both for Baden-Württemberg and Israel a differentiation is possible between three types of regions, namely agglomeration regions (i.e. central regions), urbanised regions (i.e. intermediate regions), and rural regions (i.e. peripheral regions). In section 4 the results of a shift-share analysis are discussed which was carried out to identify the contribution of structural and locational factors to

regional growth. Section 5 summarises the empirical results and derives regional policy conclusions.

Regional Distribution and Concentration of FGIs in Baden Württemberg and Israel

Baden-Württemberg is one of the "industrial motors" in Germany (BECHER *et al.*, 1992). According to the official German classification of 1992 from the Bundesforschungsanstalt für Landeskunde und Raumordnung (BfLR; now Bundesamt für Bauwesen und Raumordnung), this federal state consists of 12 planning regions of which three belong to the group of central regions ("Unterer Neckar", comprising the cities of Mannheim and Heidelberg; "Mittlerer Oberrhein", i.e. Karlsruhe and Baden-Baden; "Mittlerer Neckar", i.e. Stuttgart agglomeration area), six to intermediate zones and three to peripheral regions (cf. Fig. 1). 28 % of all manufacturing employees in Baden-Württemberg work within the region of Mittlerer Neckar. Unterer Neckar follows in second place with 9.5 % (cf. Tab. 1). This difference clearly shows the dependency of Baden-Württemberg's economic performance on industrial developments in the Stuttgart area. The economic crisis in Germany, following unification in the early 1990s hit Baden-Württemberg more strongly than other federal states. Therefore FGIs in Baden-Württemberg lost relatively more employment than this sector in whole West Germany (-11.5 % and -9.6 % respectively for the period 1989 to 1994).

Fig. 1: Major Regional Division of Baden-Württemberg



Tab. 1: Population, employment and manufacturing employment in Baden-Württemberg 1988/89 - 1994 according to regions (in %)

Region*	Population		Number of employees		Number of manufacturing employees		Employment in FGIs	
	1988	1994	1989	1994	1989	1994	1989	1994
Unterer Neckar (C)	11.0	10.8	11.1	11.1	9.7	9.5	11.8	11.7
Franken (I)	7.8	8.1	7.3	7.7	7.4	8.0	7.3	7.7
Mittlerer Oberrhein (C)	9.4	9.3	9.5	9.8	8.1	8.4	9.1	9.5
Nordschwarzwald (I)	5.5	5.6	5.0	5.0	5.4	5.5	4.0	4.1
Mittlerer Neckar (C)	25.5	25.0	29.1	28.1	29.9	28.4	34.9	33.1
Ostwürttemberg (P)	4.3	4.3	4.0	4.0	5.1	5.2	4.5	4.6
Donau-Iller (I)	4.5	4.6	4.5	4.6	4.6	4.8	5.0	5.3
Neckar-Alb (I)	6.4	6.5	6.0	5.8	6.5	6.3	5.0	5.0
Schwarzwald-Baar-Heuberg (P)	4.6	4.6	4.7	4.5	5.8	5.6	4.6	4.5
Südlicher Oberrhein (I)	9.3	9.4	8.5	8.9	7.1	7.5	5.7	5.8
Hochrhein-Bodensee (I)	6.1	6.1	5.2	5.3	5.2	5.3	4.2	4.5
Bodensee-Oberschwaben (P)	5.6	5.7	5.1	5.2	5.2	5.5	3.9	4.2
Total (%)	100.0	100.0	100.0	100.0	100.0	100.0	100.	100.
Total ('000)	9,408.3	10,261.1	3,661.8	3,761.8	1,720.3	1,553.1	944.	835.

* C = central region, I = intermediate region, P = peripheral region

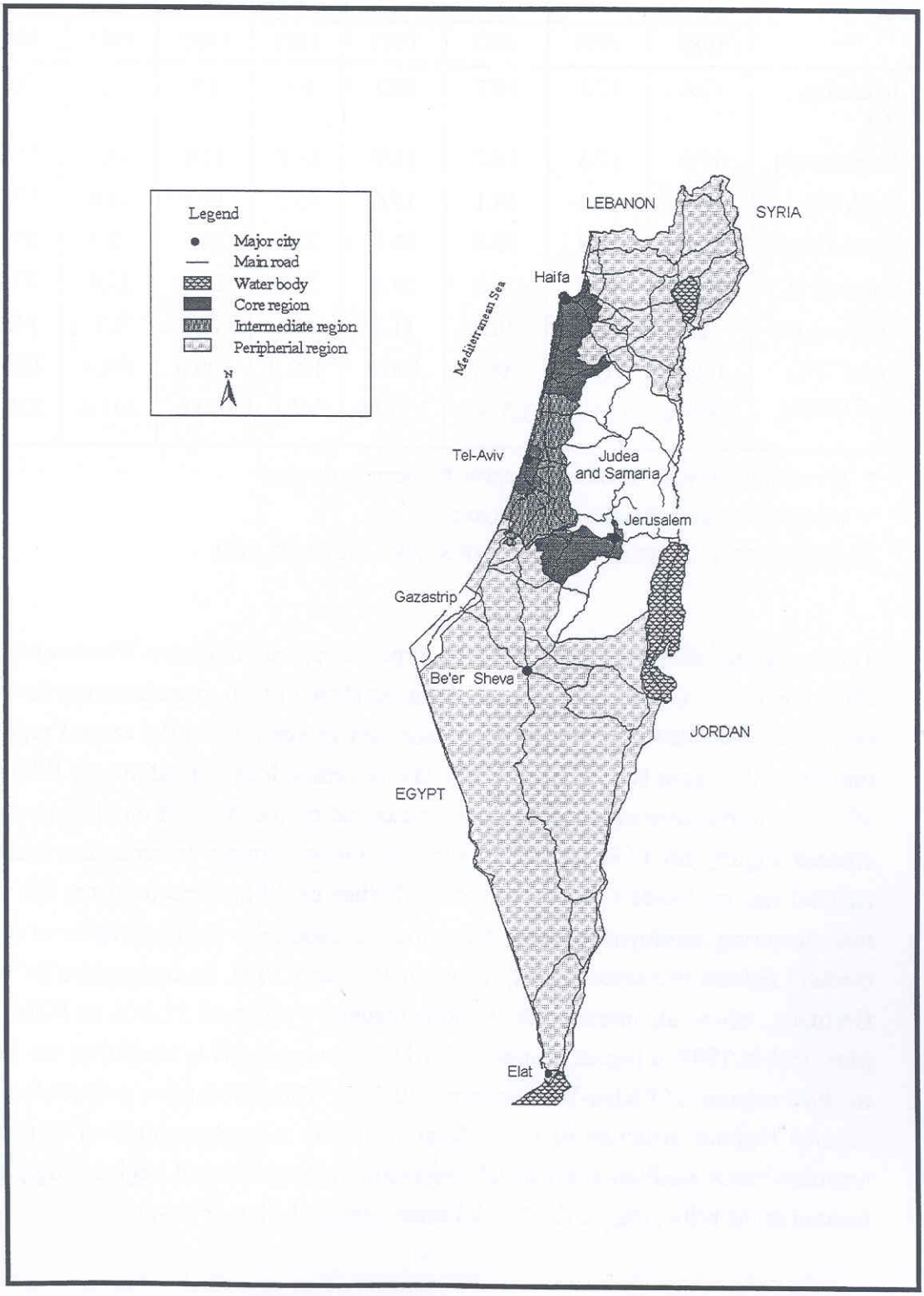
Source: BfLR, 1996; STATISTISCHES LANDESAMT BADEN-WÜRTTEMBERG, 1989, 1995

Israel consists of six districts, of which Tel Aviv and the Central district, which surrounds the city of Tel Aviv-Yafo and reaches from Netanya in the north to Rehovot in the south, are the largest according to size of population. The Northern district (the Galilee) is located east of Haifa bordering Lebanon and Syria and the Southern district reaches from the city of Ashdod at the Mediterranean Sea to Eilat at the Red Sea (the Negev). The six districts are classified by the Central Bureau of Statistics into three types of regions where Jerusalem, Haifa and Tel Aviv belong to the central type, the Central district to the intermediate type, and the Northern and Southern district to the peripheral type (cf. Fig. 2). Due to the limited number of districts, this classification can only be very rough, neglecting that between bordering central and peripheral districts vital and fast growing intermediate zones exist. This is true for northern districts, where in the hinterland of Haifa a dynamic intermediate area is situated, and for southern Israel as well. Since changes in population and economic activity in these areas are not reflected in our data, interpretations with respect to the dynamics in the locational pattern of FGIs may be misleading to some extent. The statistical classification into six districts for which data are only available makes it also difficult to compare Israel's spatial structure with the one of Baden-Württemberg where 12 districts allow a more detailed analysis.

Between 1987 and 1993 Israel recorded a population growth of 16.2 %, mainly because of the influx of Russian immigrants (cf. Tab. 2). As a result, not only the number of employees increased (+ 24.2 %), but also employment in manufacturing (+ 8.3 %) and particularly in FGIs (+ 14.9 %). The increase in manufacturing employment can mainly be attributed to an above average growth of 55 % in the Northern district, whereas the Central district recorded a decline in manufacturing employment by about 14 %. The region with the highest number of FGI employees in 1993 is the Central district (27.9 % of all FGI employment), followed by Tel Aviv (23.1 %) and the Northern district (17.3 %). Compared to the overall share of FGIs in total manufacturing in Israel (35 % in 1993), only the district of Haifa and the Central district have an above average proportion of FGIs (39.6 % and 45.4 %, respectively). The share of this industrial sector is about average in the Southern district (35.1 %) and below average in Tel Aviv (31.8 %), the Northern district (28.9 %) and in Jerusalem (19 %). Haifa's FGI employment remained stable between 1987 and 1993, while these industrial branches reduced their employment figures by - 5.5 % in the Central district. The strongest increase can be observed in Jerusalem (+ 169 %), although the absolute employment figures are still low (only

3,500 in 1993). In the other three districts the number of employees in FGIs increased as well.

Fig. 2: Major Regional Division of Israel



Tab. 2: Population, employment and manufacturing employment in Israel 1987-1993 according to districts (in %)

Districts*	Population		Number of employees		Number of manufacturing employees		Employment in FGIs	
	1987	1993	1987	1993	1987	1993	1987	1993
Jerusalem (C)	12.4	12.1	10.7	10.3	5.7	5.5	1.3	3.0
Northern (P)	17.0	17.3	14.7	15.9	14.7	17.9	13.1	17.3
Haifa (C)	13.6	13.6	14.1	13.6	15.7	15.1	19.6	17.1
Central (I)	21.6	21.8	23.4	23.1	27.2	24.6	33.9	27.9
Tel-Aviv (C)	23.3	21.9	26.2	25.4	25.3	25.4	23.0	23.1
Southern (P)	12.1	13.3	10.9	11.7	11.4	11.5	9.1	11.6
Total** (%)	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Tot**('000)	4,486.6	5,211.3	1,378.7	1,712.0	308.0	333.6	101.6	116.7

* C = central region, I = intermediate region, P = peripheral region

** not including Judea, Samaria and Gaza strip

Source: CENTRAL BUREAU OF STATISTICS, 1987, 1989, 1993, 1994

The aggregate distribution of FGIs by type of region in Baden-Württemberg is shown in Tab. 3. Compared to the employment share of total manufacturing for both reference years, fast growing industries are over represented in the central regions, indicating that these branches especially favour central locations. Between 1989 and 1994, the dominance of central regions, measured by the share of employment, decreased slightly for FGIs as well as for total manufacturing. Intermediate and peripheral regions locate a lesser share of FGIs than could be expected from the total manufacturing employment share. Nevertheless, especially the importance of intermediate regions increased slightly between 1989 and 1994. In comparison to West Germany, where all intermediate regions reached a share of 27.8 % in FGIs employment in 1994, a higher proportion of fast growing firms is located in the intermediate regions of Baden-Württemberg (32.4 %). This distribution reflects the traditional regional structure of this federal state with a larger number of originally resource-based medium-sized metal processing and mechanical engineering plants located in the hilly areas of the Black Forest outside the larger towns.

Tab. 3: Employment shares of FGIs in Baden-Württemberg (in %)

	1989		1994	
Type of region	Total Manuf.	Fast growing	Total Manuf.	Fast growing
Central	47.6	55.8	46.3	54.3
Intermediate	36.3	31.1	37.4	32.4
Peripheral	16.1	13.1	16.3	13.3
Total	100.0	100.0	100.0	100.0

Source: own calculations based on Tab. 1

Tab. 4 depicts the distribution of the manufacturing sector and FGIs by type of region in Israel. In 1987 the employment distribution both in total manufacturing and in fast growing industrial branches represents a centre-periphery descent. The majority of employees had their workplace in the central regions (46.8 % and 43.9 % respectively). Less than one quarter of FGI employees worked in peripheral regions. This pattern has not changed in 1993. Although employment in the central regions grew more slowly than the average they remained in the first position. Due to a slight decrease in employment in the intermediate region and an above average increase in the two peripheral regions these two types changed their position. This is especially true for total manufacturing employees, where the employment share in the periphery increased from 26 % to 29.4 %, as well as for FGIs. 28.9 % of all FGI employees can be found in the periphery, while their share in the intermediate region had been reduced from 34.0 % to 27.9 %. Nevertheless, only in the intermediate region can a higher share of employment in FGIs be found, compared to total manufacturing employment. Thus the intermediate region, located in proximity to Tel Aviv area appears to be, at least in relative terms, an attractive location for fast growing branches.

Tab. 4: Employment share of FGIs in Israel (in %)

	1987		1993	
Type of region	Total Manuf.	Fast growing	Total Manuf.	Fast growing
Central	46.8	43.9	45.9	43.2
Intermediate	27.2	34.0	24.6	27.9
Peripheral	26.0	22.1	29.4	28.9
Total	100.0	100.0	100.0	100.0

Source: own calculations based on Tab. 2

So far the spatial distribution of FGIs was analysed on the basis of relative figures (i.e. per cent shares) which do not provide an answer to the question if FGIs are spatially concentrated or dispersed. Regional concentrations can be measured by the weighted variation coefficient (GV).[2] GV calculates the variance of a relative statistical variable and is therefore used as a measure of relative concentration. At a GV = 0 the variable is equally distributed over space. The higher the coefficient, the stronger is the concentration. If spatial units remain unchanged in time, comparisons between different years are possible for analysing the dynamics of regional concentration processes.

Weighted variation coefficients were calculated for 1989 and 1994 as depicted in Tab. 5. According to these coefficients FGIs are not equally distributed in Baden-Württemberg, but are to some extent spatially concentrated. Since GV might run into infinity, figures around 0.2 can be interpreted as a fairly moderate concentration. The comparison of coefficients for different years allows a better estimation of the dynamics of spatial concentration. Between 1989 and 1994 the concentration measured by the different variables (population and employment) decreased slightly. The highest decrease can be found in the population-based coefficient, an indication for the dispersal effects of the population growth in the early 90s. This might be attributed to the fact that between 1988 and 1994 the population of Baden-Württemberg grew by 800,000 inhabitants (a rate very similar to West Germany which grew by 4 million). The major source of this growth is the influx of migrants from East Germany and German immigrants from the former Soviet Union. The immigrants found their new homes mostly in the intermediate and the peripheral regions and therefore contributed slightly to the spatial dispersion of population (JONES, 1992). Nevertheless, due to the stagnation of peripheral regions the spatial dispersion process was only very moderate in Baden-Württemberg (on an already quite low concentration background) and favoured mainly the intermediate regions which increased their share in total FGI employment slightly.

Tab. 5: Spatial concentration of fast growing industries (FGIs) in Baden-Württemberg 1989 and 1994

Weighted variation coefficient	1989	1994
Employment FGIs/Population	0.266	0.242
Employment FGIs/Total employment	0.177	0.166
Employment FGIs/Manufacturing Employment	0.182	0.170

Source: own calculations based on Tab. 1

As a result of the growth in FGI employment in Israel's periphery, the spatial concentration decreased strongly between 1987 and 1993 according to the weighted variation coefficients shown in Tab. 6. The dispersion process was much stronger than in Baden-Württemberg, although it should not be forgotten that due to the different number of regional units an identical comparison between Israel and Baden-Württemberg is not possible. Concentration is still relatively high in Israel with respect to total employment and population. On the other hand, the coefficients for manufacturing employment reached nearly the same value in Israel and Baden-Württemberg for 1993 and 1994, respectively.

Tab. 6: Spatial concentration of fast growing industries (FGIs) in Israel 1987 and 1993

Weighted variation coefficient	1987	1993
Employment FGIs / Population	1.008	0.536
Employment FGIs / Total employment	0.852	0.432
Employment FGIs / Manufacturing Employment	0.433	0.173

Source: own calculations based on Tab. 2

Bearing in mind the different number of regions and the somewhat straitened comparability between both countries, the comparison of the spatial pattern of FGIs distribution between Baden-Württemberg and Israel reveals the following:

- The FGIs share in central regions is lower in Israel compared with Baden-Württemberg (43.2 % and 54.3 % for 1993/94 respectively).
- In Baden-Württemberg's central regions FGIs are over represented compared to the regions' share in total manufacturing. In Israel this overrepresentation can be found in the intermediate region.
- Between the two reference years the growth in FGI employment was much faster in Israeli peripheral regions than in the Baden-Württemberg periphery.
- In Baden-Württemberg a slight increase in FGI employment could be observed for intermediate regions while in Israel there was an employment decrease in this type of region.

- Spatial concentration decreased in both countries while the coefficients reveal a stronger spatial dispersion process in Israel than in Baden-Württemberg, pointing to a decline in regional disparities of the spatial distribution of FGIs in Israel.

Spatial Dynamics of FGIs in Baden-Württemberg and Israel

The shift-share analysis provides indications to the causes of regionally diverging growth rates. It consists of the regional factor (RF) which measures the growth of a variable (e.g. employment in FGIs) between the year t_0 and the year t_1 in a given region compared with the growth of the same variable in all regions. The structural factor (STRU) analyses if the regional growth differences can be attributed to the existence of growth intensive or shrinking branches in relation to the growth of these branches in all regions. The locational factor (LOC) measures the variations in regional branch shares at the changes in regional shares and is therefore an indicator for locational effects in regional growth. If a region grows like the total spatial entity, RF, STRU and LOC are equal to 1. If it grows below average, the measures are less than 1; if it grows above average, the measures are larger than 1. The regional factor equals to the locational factor times the structural factor (GERFIN, 1964; SCHÄTZL, 1994). Although the shift-share analysis is a helpful tool for analysing spatial dynamics, it should be noted that the locational factor does not reflect the real locational conditions in a region, but indicates growth deviations between the different regions in a dataset which are interpreted as favourable respectively unfavourable locational conditions.

The results of the shift-share analysis for the three types of regions and the 12 planning regions of Baden-Württemberg are shown in Tab. 7. The above average growth of FGIs in intermediate regions has its major cause in regionally attributable growth conditions, while the structural growth component indicates only a slight above average growth. In peripheral regions, the above average regional growth component contributes to the regional factor > 1; the industrial composition had slightly decreasing effects on employment growth. FGIs located in central regions of Baden-Württemberg grew more slowly than the average. Here, it is mainly because of regional conditions, while the structural mix has no negative growth effects. Looking at the single regions, the shift-share analysis reveals the following growth pattern. Highest growth can be found in Hochrhein-Bodensee, Bodens-ee-Oberschwaben, Franken, Donau-Iller and Mittlerer Oberrhein, besides

Tab. 7: Shift-share analysis for regions in Baden-Württemberg 1989-1994

Regional Type	RF	STRU	LOC
Central (= C)	0.973	0.998	0.975
Intermediate (= I)	1.043	1.008	1.035
Peripheral (= P)	1.013	0.992	1.021
Planning Region			
Unterer Neckar (C)	0.987	1.016	0.972
Franken (I)	1.059	1.006	1.052
Mittlerer Oberrhein (C)	1.048	1.008	1.040
Nordschwarzwald (I)	1.040	0.992	1.048
Mittlerer Neckar (C)	0.949	0.989	0.960
Ostwürttemberg (P)	1.002	0.988	1.014
Donau-Iller (I)	1.054	1.009	1.045
Neckar-Alb (I)	1.005	0.993	1.012
Schwarzwald-Baar-Heuberg (P)	0.979	0.982	0.997
Südlicher Oberrhein (I)	1.025	1.021	1.003
Hochrhein-Bodensee (I)	1.075	1.024	1.050
Bodensee-Oberschwaben (P)	1.066	1.008	1.057

Source: own calculations based on BfLR data

Mittlerer Oberrhein all intermediate or peripheral regions. Especially in Hochrhein-Bodensee, a region bordering France and Switzerland in the south of Baden-Württemberg, and Südlicher Oberrhein (greater Freiburg area) the above average employment growth had a strong structural component. In Freiburg it is mainly the plastics industry, in Hochrhein-Bodensee the electric and electronic equipment industry which contributed to this growth. There are only three regions in Baden-Württemberg in which the regional factor remained below 1: Unterer Neckar, here with slight structural advantages, Mittlerer Neckar, both central regions, and Schwarzwald-Baar-Heuberg, a generally dynamic peripheral region, but obviously not with respect to employment growth in FGIs. The below average growth performance of central regions was mainly due to the industrial core of the state, Stuttgart area (Mittlerer Neckar). Companies in this region reduced their employment more than in many other regions of Baden-Württemberg. Since many large, globally acting German companies have their headquarter and production sites in this area,

the employment decrease might be an indication for structural adjustment processes as a result of national recession and changing national and global competition. These companies adjusted more quickly than the many small and medium-sized enterprises in Baden-Württemberg to the needs of new competitive threats (HEIDENREICH and KRAUSS 1997). It has to be pointed out that different growth rates might occur when using turnover or production figures, which are, unfortunately, not available in the regional database of BfLR.

It is interesting to note that the structural growth component reveals average growth in those regions which are either located in the south and southwest of Baden-Württemberg (i.e. Südlicher Oberrhein, Hochrhein-Bodensee, Bodensee-Oberschwaben), bordering France and Switzerland, or in the northern part of this federal state (i.e. Unterer Neckar, Franken), bordering Rhineland-Palatinate, Hesse and Bavaria. All other regions in the "heart" of Baden-Württemberg show structural weaknesses, probably a result of the strong employment losses of firms located in the Stuttgart agglomeration.

It has already been pointed out that in Israel only the two peripheral regions recorded above average growth of FGI employment between 1987 and 1993. It is therefore interesting to see which components contributed mostly to this growth. For Israel's periphery it can clearly be said that the increase in employment is strongly based on regional growth conditions. According to the figures given in Tab. 8, the periphery seems to have a higher locational attractiveness than intermediate regions. It can be assumed that relocations from other types of region as well as the establishment of new enterprises have contributed to this growth process. Nevertheless, the structural growth component reveals only below average growth of FGIs in this type of region. In the intermediate region the below average overall growth is slightly compensated by some structural advantage, which make this region still the location of above average growing FGIs. It should not be forgotten that the growth process in Israel's only official intermediate region is not representative for all areas of an intermediate type, i.e. in the surroundings of the larger cities of the country. Here, endogenous growth processes or immigrations might occur which are hidden by using the official regional classification. Other than in Baden-Württemberg, where the central regions mainly lost growth because of regionally attributable disadvantages, it is the branch structure of Israeli FGIs located in central regions which contributes to a regional factor just below 1. Locational conditions seem to be still good. This is especially true for the second largest district

Tab. 8: Shift-share analysis for districts in Israel 1987-1993

Regional Type	RF	STRU	LOC
Central (= C)	0.984	0.888	1.108
Intermediate (= I)	0.823	1.051	0.783
Peripheral (= P)	1.312	0.666	1.969
District			
Jerusalem (C)	2.344	0.389	6.026
Northern (P)	1.322	0.664	1.991
Haifa (C)	0.871	0.995	0.875
Central (I)	0.823	1.051	0.783
Tel-Aviv (C)	1.004	0.873	1.150
Southern (P)	1.278	0.679	1.882

Source: own calculations based on Tab. 2

with respect to FGI employment, Tel-Aviv (cf. Tab. 2), while Haifa district does not seem to be a very attractive location for FGIs. Despite the high growth rates in Jerusalem, the FGI employment figures are still low, reaching only 3,500 employees in 1993. Especially for the northern part of Israel, the Galilee, it can be concluded from the data that interregional decentralisation processes occurred between 1987 and 1993. This is not only supported by the substantial decrease in the spatial concentration as indicated by the weighted variation coefficients, but also by the shift-share analysis which records below average growth for the Haifa district and above average growth for the northern district, based on favourable regional growth conditions.

Regional Policy Conclusions

It was the objective of the paper to find out whether FGIs can be made the starting point for industrial decentralisation strategies in Israel and how the observed spatial distribution of fast growing branches fits with the location pattern of these firms in Baden-Württemberg. A first major conclusion from the empirical analyses is that fast growing industries reveal location behaviour as predicted by many theories. Both in Baden-Württemberg and in Israel FGIs are mainly located in central, metropolitan regions. Nevertheless, returning to the research question concerning the spatial adjustment flexibility formulated at the beginning of this paper it can be assumed that growth resources have been utilized outside the metropolitan areas.

While in Baden-Württemberg mainly intermediate regions profited from the economic performance of FGIs, a same clear conclusion could not be drawn for Israel because of the relatively rough spatial delimitation used by the Central Bureau of Statistics. Looking at the northern part of Israel, a centre-periphery employment movement is obvious, resulting in stable employment figures in Haifa between 1987 and 1993 and a quite strong increase in the Northern district. Locational disadvantages in Haifa are faced by locational advantages in areas outside of Haifa. It is therefore our conclusion that not only peripheral regions, but also intermediate areas located between the central and peripheral region recorded high increase in employment.

A second major conclusion is that in Israel economic and political circumstances seem to favour the growth of non-central regions. Scarcity of labour and industrial sites, especially in the northern agglomeration area of Haifa, the political interest to strengthen the northern and southern peripheral districts by attracting new firms to these areas and the already existing production facilities in the *kibbutzim*, which are important plastics producers and which diversify their product spectrum, for example, to electronic assembly, have strong supportive effects to spatial decentralisation of economic activities. This can be interpreted as an indication that at least certain fast growing industries can realise knowledge slipovers outside the metropolitan areas. For supporting growth potentials outside the urban cores, the Israeli government implemented regional development strategies targeting the Negev and the Galilee as "Region 2000" by stimulating high-technology industrial development including a spatially balanced growth there (SHEFER and BAR-EL 1993). It seems too early to attribute the observed spatial dispersal of industrial activity to measures of the "Region 2000" plan, since its implementation started only in the early 1990s. Nevertheless, the results of the empirical analyses point to favourable preconditions for the implementation of a regional decentralisation strategy in the northern and southern parts of Israel, either towards peripheral regions, but more probable towards intermediate areas located within central and peripheral types of region. Other than in Baden-Württemberg, where firms even located in peripheral areas can profit from external effects generated by economic activities in neighbouring states, decentralisation in Israel, especially in the northern region, is solely a result of endogenous development processes and not influenced by economic activities located outside the Israelian border.

For Baden-Württemberg, the increase in the relative FGI employment share in intermediate regions (at an absolute reduction of employment in all regions) fits well into the general spatial development processes in Germany. Fast growing regions with respect to employment and population growth are located in the hinterland of agglomerations, which are, by BfLR definition, mainly intermediate regions. This suburbanisation process does not only apply to FGIs, but to new technology-based firms as well (NERLINGER and BERGER, 1995). The lower variation coefficients for Baden-Württemberg (as well as their lower decrease) compared to Israel might at least have some explanation in the fact that regional policy practised for decades and the objective of article 72 of Germany's constitution to create similar living conditions within whole Germany more strongly affected the reduction of regional disparities in industrial activities in Baden-Württemberg than recent policy measures in Israel can do so far (WALTER, 1997).

What can be learned from this comparison between Baden-Württemberg and Israel regarding regional policy and the objective of strengthening regional economic capabilities in non-metropolitan regions? The observed decentralisation process of FGIs in both regions make it clear that these industries can be, under certain circumstances, an important target group for regional policy. Fast growing industrial branches in particular which do not rely strongly on proximity to metropolitan areas in order to realise external effects can significantly contribute to employment and income outside the industrial and economic cores. Nevertheless, proximity to the central area, as is the case for most non-central regions in Baden-Württemberg and Israel is a supportive factor for fostering the decentralisation process. Therefore this kind of industrial decentralisation can be expected especially in spatial systems in which the intermediate or peripheral areas are not located far remote the urban core, but within the reach of major agglomerations. A precondition for the successful implementation of a spatial decentralisation strategy is that the different types of regions are functionally linked by fulfilling different functions in a spatial system (STORPER, 1997). In Northern Israel, for example, the peripheral area originally served as an agricultural settlement region for the *kibbutzim* and as food supplier for urban regions. Diversifying their activity, *kibbutzim* are not only engaged in agricultural production, but attracted many immigrants from different countries by offering employment opportunities in industrial production, e.g. the manufacturing of plastic products or electronic components. Due to these employment and income opportunities in the periphery, the linkages between the regions did not lead to centripetal counter effects and to an increase in regional disparities. On the contrary, the

already developed economic base of the periphery made decentralisation possible. Nevertheless, it should not be forgotten that this decentralisation of industrial activity was not disturbed respectively fostered by external influences due to the missing economic linkages to neighbouring countries. It was the result of endogenous processes and by this emphasises that also in spatial systems without a hinterland a periphery can develop locational attractiveness by its own. This characteristic might not apply to every peripheral or intermediate region, but is the lesson which can be learnt from the case study presented here.

Endnotes

1 The major source for regional data in Germany used in this analysis is the Bundesforschungsanstalt für Landeskunde und Raumordnung (BfLR). Since BfLR (now Bundesamt für Bauwesen und Raumordnung) applies the systematics of industrial groups of the Federal Labour Office for branch classifications, slight deviations in branch definitions compared to the SIC had to be accepted.

2 The weighted variation coefficient (GV) is calculated according to the following formula:

$$GV = \frac{\sqrt{\sum_{i=1}^{n} \left(\frac{Y_i}{P_i} - \frac{Y}{P} \right)^2 \frac{P_i}{P}}}{\frac{Y}{P}}$$

whereas
P = Employment in FGIs
Y = Variable (b), i.e. total employment, population or total manufacturing employment
i = Region
k = cumulated shares

Source: SCHÄTZL, 1994

REFERENCES

ARMSTRONG H. and TAYLOR J. (1993) *Regional Economics and Policy.* Second edition. Harvester Wheatsheaf, New York.

BAHRENBERG G., GIESE E., NIPPER J. (1985) *Statistische Methoden in der Geographie. Band 1: Univariate und bivariate Statistik.* Teubner, Stuttgart.

BECHER G., KUHLMANN S., KUNTZE U., BACARIA J., CLAVERA J., RIVA A., RABELLOTTI R., COLLETIS G., KUKAWKA P. (1992) *The Four Motors for Europe. Analysis of a Cooperation Experiment.* Final Report. MONITOR-FAST, Dossier No. 1. EU Commission, Brussels.

BfLR [BUNDESFORSCHUNGSANSTALT FÜR LANDESKUNDE UND RAUMORDNUNG] (1996) Industry data from data file "Laufende Raumbeobachtung" for the years 1989 and 1994. Bonn.

BRACZYK H.-J., SCHIENSTOCK G., STEFFENSEN B. (1995) The Region of Baden-Württemberg: a Post Fordist Success Story?, in DITTRICH E.J., SCHMIDT G., WHITLEY R. (Eds) *Industrial Transformation in Europe. Process and Contexts*, pp 203-233. SAGE Publications, London.

CENTRAL BUREAU OF STATISTICS (1987) *Industry and Crafts Surveys 1987.* Jerusalem.

CENTRAL BUREAU OF STATISTICS (1989) *Statistical Abstract of Israel 1989.* Jerusalem.

CENTRAL BUREAU OF STATISTICS (1993) *Industry and Crafts Surveys 1993.* Jerusalem.

CENTRAL BUREAU OF STATISTICS (1994) *Statistical Abstract of Israel 1994.* Jerusalem.

CONTI S. (1995) Four paradigms of the enterprise system, in CONTI S., MALECKI E.J., OINAS P. (Eds) *The Industrial Enterprise and Its Environment: Spatial Perspectives*, pp. 59-97. Avebury, Aldershot.

COOKE P. and MORGAN K. (1994) The regional innovation system in Baden-Wuerttemberg, *Int. J. Technology Management* **9**, 394-429.

COOKE P., MORGAN K., PRICE A. (1993) *The Future of the Mittelstand. Collaboration versus Competition.* University of Wales, Cardiff.

DAVELAAR E.J and NIJKAMP, P. (1997) Spatial Dispersion of Technological Innovation, in BERTUGLIA C.S., LOMBARDO S., NIJKAMP P. (Eds) *Innovative Behaviour in Space and Time*, pp. 17-40. Springer, Berlin.

DAVELAAR E.J. (1991) *Regional Economic Analysis of Innovation and Incubation.* Billing&Sons, Worcester.

DOSI G., PAVITT K., SOETE L. (1990) *The Economics of Technical Change and International Trade.* Harvester Wheatsheaf, New York.

DUIJN J.J.V. (1983) Fluctuations in Innovations over Time, in FREEMAN C. (Ed) *Long Waves in the World Economy,* pp. 19-30. Frances Pinter, London.

FELDMAN M.P. and FLORIDA R. (1994) The Geographic Sources of Innovation: Technological Infrastructure and Product Innovation in the United States, *Ann. Ass. Am. Geographers* **84**, 210-229.

FELDMAN M.P. and KUTAY A.S. (1997) Innovation and Strategy in Space: Towards a New Location Theory of the Firm, in BERTUGLIA C.S., LOMBARDO S., NIJKAMP P. (Eds) *Innovative Behaviour in Space and Time*, pp. 239-250. Springer, Berlin.

FRENKEL A., SHEFER D., KOSCHATZKY K., WALTER G.H. (1997) Regional Innovation Profiles of Firms in Fast-Growing Industries: A German-Israel Comparison, in THE S. NEAMAN INSTITUTE and MIT ENTERPRISE FORUM OF ISRAEL (Eds) *Innovation: Technology Assessment, Forecasting, Strategy and Regional Policy*, pp. 43-72. S. Neaman Institute. Haifa.

FRIEDMANN J. (1966) *Regional development policy : A case study of Venezuela.* MIT Press, Cambridge.

GERFIN H. (1964) Gesamtwirtschaftliches Wachstum und regionale Entwicklung, *Kyklos* **17**, 565-593.

GROSSMAN G.M. and HELPMAN E. (1990) Comparative Advantage and Long-Run Growth, *Am. Econ. Rev.* **80**, 796-815.

GROSSMAN G.M. and HELPMAN E. (1991) *Innovation and Growth in the Global Economy.* MIT Press: Cambridge.

HAMPE J. and KOLL R. (1989) Regionale Entwicklung und langfristiger Wandel der Arbeitsteilung: Theoretische Zusammenhänge und empirische Analyse am Beispiel der langfristigen Entwicklung ausgewählter Sektoren in Bayern, in BÖVENTER E.V. (Ed) *Regionale Beschäftigung und Technologieentwicklung,* pp 39-80. Duncker und Humblot, Berlin.

HASSINK R. (1996) Regional Technology Policies in the Old and New Länder of Germany, *European Urb. Reg. Studies* **3**, 287-303.

HEIDENREICH M. and KRAUSS G. (1997) Das baden-württembergische Produktions- und Innovationsmodell: zwischen vergangenen Erfolgen und neuen Herausforderungen, in HEIDENREICH M. (Ed) *Innovationen in Baden-Württemberg*, pp. 17-31. Nomos, Baden-Baden.

ISARD W. (1956) *Location and Space-Economy. A General Theory Relating to Industrial Location, Market Areas, Land Use, Trade and Urban Structure.* MIT Press, Cambridge/Mass.

ISARD W. (1960) *Methods of Regional Analysis. An Introduction to Regional Science.* Technology Press of MIT, New York.

JAFFE A.B., TRAJTENBERG M., HENDERSON R. (1993) Geographic Localization of Knowledge Spillovers as evident by Patent Citations, *Quart. J. Econ.* **108**, 577-598.

JONES P.M. (1992) Western Germany's 'Third Wave' of Migrants: the Arrival of the Aussiedler, *Geoforum* **23**, 1-11.

KEEBLE D. (1997) Small Firms, Innovation and Regional Development in Britain in the 1990s, *Reg. Studies* **31**, 281-293.

KLEINKNECHT A. and POOT, T.P. (1992) Do Regions Matter for R&D? *Reg. Studies* **26**, 221-232.

KOSCHATZKY K. (1997a) Innovationsdeterminanten im internationalen Vergleich: Möglichkeiten zur Stärkung regionaler Innovationspotentiale, *Geographische Zeitschrift* **25**, 97-112.

KOSCHATZKY K. (1997b): Innovative Regional Development Concepts and Technology-Based Firms, in KOSCHATZKY K. (Ed) *Technology-based Firms in the Innovation Process: Management, Financing and Regional Networks,* pp. 177-201. Physica, Heidelberg.

KRAUSS G. (1996) Innovation and Restructuring in Baden-Wuerttemberg, in KUKLINSKI A. (Ed) *Production of Knowledge and the Dignity of Science*, pp. 96-113. University of Warsaw, Warsaw.

LUCAS R.E. (1988) On the Mechanics of Economic Development, *J. Mon. Econ.* **22**, 3-42.

LYONS D. (1995) Agglomeration Economies among High Technology Firms in Advanced Production Areas: The Case of Denver/Boulder, *Reg. Studies* **29**, 265-278.

MEYER-KRAHMER F. (1985) Innovation Behaviour and Regional Indigenous Potential, *Reg. Studies* **19**, 523-534.

NERLINGER E. and BERGER G. (1995) *Regionale Verteilung technologieorientierter Unternehmensgründungen.* Discussion Paper Series, ZEW Mannheim, No. 95-23. ZEW, Mannheim.

OAKEY R.P. (1984) Innovation and Regional Growth in Small High Technology Firms: Evidence from Britain and the USA, *Reg. Studies* **18**, 237-251.

OAKEY R.P. and COOPER S.Y. (1989) High technology industry, agglomeration and the potential for peripherally sited small firms, *Reg. Studies* **23**, 347-369.

ROMER P.M. (1986) Increasing Returns and Long-Run Growth, *J. Polit. Econ.* **94**, 1002-1037.

ROMER P.M. (1987) Growth Based on Increasing returns Due to Specialization, *Am. Econ. Rev.* **77**, 56-62.

ROSENBERG N., LANDAU R., MOWERY D.C. (Eds) (1992) *Technology and the Wealth of Nations*. Harford University Press, Stanford.

SCHÄTZL L. (1994) *Wirtschaftsgeographie 2. Empirie.* Second edition. Schöningh, Paderborn.

SCHÄTZL L. (1996) *Wirtschaftsgeographie 1. Theorie.* Sixth edition. Schöningh, Paderborn.

SCOTT A.J. (1995) The Geographic Foundations of Industrial Performance, *Comp. & Change* **1**, 51-66

SEMLINGER K. (1993) Economic development and industrial policy in Baden-Wuerttemberg: Small firms in a benevolent environment, *European Plan. Studies* **1**, 435-464.

SHEFER D. (1993) Location of High Technology Industries and Regional Development - The Israeli Case, *Rev. Urb. Reg. Dev. Studies* **5**, 206-219.

SHEFER D. and BAR-EL E.L. (1993) High-technology industries as a vehicle for growth in Israel's peripheral regions, *Environ. Plan. C* **11**, 245-261.

SHEFER D., FRENKEL A., KOSCHATZKY K., WALTER G.H. (1997) Targeting Industries for Regional Development in Israel and in Germany - A Comparative Study. *Working Paper, S. Neaman Institute*. Haifa.

SIMMIE J. (1997) Origins, Structure and Contents, in SIMMIE J. (Ed) *Innovation, Networks and Learning Regions.* Regional Policy and Development Series 18, pp. 3-9. Jessica Kingsley Publ., London.

STATISTISCHES LANDESAMT BADEN-WÜRTTEMBERG (1989) *Statistisches Taschenbuch 1988/89.* Metzler-Poeschel, Stuttgart.

STATISTISCHES LANDESAMT BADEN-WÜRTTEMBERG (1995) *Statistisches Taschenbuch 1995.* Metzler-Poeschel, Stuttgart.

STORPER M. (1995) The Resurgence of Regional Economies, Ten Years Later: The Region as a Nexus of Untraded Interdependencies, *Eur. Urb. Reg. Stud.* **2**, 191-221.

STORPER M. (1997) *The Regional World. Territorial Development in a Global Economy.* Guilford Press, New York

TICHY G. (1991) The product-cycle revisited: Some extensions and clarifications, *Zeitschrift für Wirtschafts- und Sozialwissenschaften* **111**, 27-54.

VAESSEN P. and KEEBLE D. (1993) Spatial responsiveness of small firms, *Tijdschrift voor Economic and Social Geography* **84**, 119-131.

VAESSEN P. and KEEBLE D. (1995) Growth-oriented SMEs in Unfavourable Regional Environments, *Reg. Studies* **29**, 489-505.

WALTER G.H. (1997): Aims and Instruments of Regional Technology Policy: the Example of Baden-Württemberg, in WALTER G.H. (Ed) *Slovenian-German Co-operation in the Field of Technology Policy. Lectures on Technology Transfer, Innovation Financing, Evaluation 1993-1997 - a Handbook.* MOEL-Working Paper No. 76. Fraunhofer Institute for Systems and Innovation Research, Karlsruhe.

Appendix D

Industrial Pattern Characteristics, Production Milieu, and Regional Innovation: A Comparison Between Israeli and German Plants

Amnon Frenkel[**], Daniel Shefer[**], Knut Koschatzky[*], Guenter H. Walter[*]

Submitted to *Regional Study*

** S. Neaman Institute for Advanced Studies in Science and Technology, Technion - Israel Institute of Technology, Haifa, Israel.

* Fraunhofer Institute for Systems and Innovation Research, Karlsruhe, Germany.

ABSTRACT

In recent years, we have been witnessing a growing number of researchers whose objective is to gain a better understanding of the variation in the rate of spatial innovation of different industrial plants. Several studies have investigated the similarity and dissimilarity of spatial innovation between countries. This study 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 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-variable Logit Models, enabled us to point out the similarity and dissimilarity in spatial innovation patterns between the two countries. The results further support the hypothesis that expenditure on R&D is a good surrogate for the share of innovative firms, regardless of the industrial branch to which the plant belongs.

In general, we can conclude that there exists a strong similarity in the frequency of industrial innovation in both countries; i.e., the share of innovative firms in their hi-tech industries is significantly higher than in their traditional industries. On the other hand, the pattern of spatial variations in the share of innovative firms in Israel is much more pronounced and visible compared to Germany.

Key words: Spatial innovations, fastest growing-industries, industrial innovation in Germany, industrial innovation in Israel.

1. Introduction

In recent years there has been an increase in the number of empirical studies attesting to inter-regional variations in the rate of innovation, both within and between countries. International comparisons of the regional behavior of industrial plants, and the innovation processes characterizing them, are becoming increasingly important following world economic globalization and the transformation of the world into 'one small village' (Alderman and Fischer, 1992; Suarez-Villa and Fischer, 1995; Suarez-Villa and Han, P-H., 1990, 1991; Suarez-Villa and Karlsson, 1996; Suarez-Villa and Rama, 1996; Nelson, 1993; Kleinknecht, 1996; Roper et.al, 1996). The international comparison is particularly interesting in this study since it compares the rate of innovation in a country with an established industrial innovation with a country that only recently gain the innovation game, particularly in the hi-tech industries.

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, and a German team from the Fraunhofer Institute for Systems and Innovation Research in Karlsruhe, Germany. The research is supported financially by the German-Israel Fund (GIF) for the sciences. The paper presents the results of a comparative analysis of empirical data gathered from both Israel and Germany. It enables examination of the inter and intra-regional variations of innovation occurring in these countries, as well as the differences and similarities in the factors influencing the creation of innovation, from the inter-regional and international perspectives. The analysis was based on data collected recently during field surveys conducted simultaneously by the research teams in both countries. In this paper we focus on product innovation as distinct from process innovation*.

2. The National and Regional Aspects of Innovation

The contribution of innovation to regional development is extensively reported in the literature which discuss economic growth and development, pointing out the significant role played by innovation in fostering regional economic growth (Suarez-Villa, 1993; Feldman and Kutay, 1997; Davelaar and Nijkamp, 1997).

Development of a region as an incubator for innovations is generally accompanied by the appearance of new economic activity, market expansion, and new technological

---

* For more on that aspect, see Frenkel, 1997

applications. Such regions become a preferred destination for highly skilled labor, by attracting them to migrate from other areas. These conditions promote development and in-migration of major corporate head-offices which subsequently impact 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 the competitive edge and inducing economic growth. The assumption therefore follows that regions characterized by a high rate of innovation will enjoy greater economic growth by comparison with other areas. (Grossman and Helpman, 1990, 1991, 1994; Krugman, 1979, 1991, 1995; Stokey, 1995). There is now strong evidence of the positive effect of innovation on the performance of individual business (Geroski and Machim, 1992; Kleinknecht, 1996).

The burgeoning interest in the regional perspective of innovative activity is based on the recognition of the close link between 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 adopting and creating new technologies in existing plants, while at the same time encouraging the establishment of new hi-tech firms (Feldman, 1994).

Studies focusing on the analysis of the path followed by new firms along the time-space dimensions conclude that this path generally commences in the metropolitan areas, which serve as urban incubation sites for the emergence of innovative firms (Davelaar and Nijkamp, 1988; Hoover and Vernon, 1959). Empirical studies tended to support the assumption that companies located in large metropolitan areas have a significant advantage (Thwaites, 1982; Camagni, 1984; Fischer, 1989). The conditions offered by this concentration of economic activities, which contain head-offices of large hi-tech companies, R&D facilities, information centers, etc., favor the generation of innovations. By contrast, peripheral regions are often characterized by a lower innovation capability (Fischer, 1989; Sweeney, 1987; Frenkel, 1997).

Concomitantly, there were reports of studies 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, in comparison to the central regions, Holland's more peripheral areas were found to be more promising from the perspective of attracting innovative firms. These findings, which are particularly valid for the Amsterdam metropolitan area, were accepted with a degree of reservation, since the study sample

included only small industrial firms. It may thus be assumed that, as indicated in most other studies, metropolitan areas are better suited for large industrial plants and business services (Davelaar and Nijkamp, 1989, 1992).

A regional analysis of the innovation activities in the USA focused on the variations between different states (Feldman, 1994). The research results highlighted the link between regional technological infrastructure, and the rate of innovation characteristic of the region. The study identified four variables that indicate the existence of 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 results obtained in other studies (Jaffe, 1989; Mansfield, 1991). A concentration of firms also attests to innovation activity in a region, by indicating that the technological progress gained during manufacturing processes, leads to an increase in innovation outputs. This conclusion supports the hypothesis that 'learning by doing' constitutes a significant input for 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 develop innovation (Roper and Love, 1996; Frenkel, 1997; Thwaites et al., 1981; Dosi, 1988; Rosenberg, 1985; Nelson, 1986). Various studies have indicated that R&D efforts tend to be concentrated in the larger urban areas (Malecki, 1979). However, a study conducted in the south-east of U.K. showed large concentration of R&D employment in small, rather than large, urban areas (Howells, 1984).

An international comparison of the regional distribution of R&D activity in the USA - the San Francisco Bay area, including the Silicon Valley, and the U.K - Eastern England and Scotland, showed a significant concentration of this activity in the San Francisco Bay area, compared with relatively limited activity in Scotland (Oakey, 1984). However, from the outcome of the study, it was apparent that Scotland did not demonstrate the characteristics of a development area. The study concluded that the peripheral region also contains small independent firms that develop and generate innovation.

In Holland, in-house R&D efforts, as well as outsourced R&D services, 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, rather than the peripheral regions. The intermediate regions function as if positioned between the central and peripheral regions. These results demonstrate the leading role of the metropolitan region in this context. However, in the later stages, with regional diffusion

of innovation, the emphasis turns to the improvements in manufacturing production, i.e. process innovation. Similar findings were also obtained in another empirical study recently conducted in Israel (Shefer and Frenkel, 1998).

The empirical results obtained from the various studies indicate that innovation activity is not limited solely to metropolitan or central regions (Koschatzky and Muller, 1997). It is apparent that different regions play unique and separate roles in the innovation processes. This is apparent in the spatial diffusion of new products and production processes. Therefore, the ability of the various regions to function in the long term is dependent on the interrelationships existing between them, while complementing rather than competing with each other. On the one hand, metropolitan areas provide the medium required to launch new industrial activities requiring more advanced technological systems. On the other hand, in the subsequent stage these technologies are transferred to other regions outside the metropolitan area. Due to the high cost of land, metropolitan areas are the preferred location for industries featuring recently developed technologies, which can yield a high added value. By contrast, regions, which are outside the influence of metropolitan areas, are generally unable to provide conditions necessary for the early life cycle stages of technologies and firms (Malecki and Nijkamp, 1988). It should however 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. The objectives of such a policy may even counteract the potential of some areas to grow in the long term. Furthermore, such a policy is even liable to contradict existing location preferences, thus adversely affecting regional economic growth (Frenkel, 1997).

3. The Framework of the Study

3.1 Inter-Regional Comparison

The data collected in Germany and Israel on the structure of regional innovation was concerned with industrial firms, in a selected number of fast growing industrial branches (for more details on the methodology of fast-growing industry see: Shefer et al., 1998). These included the following three major branches of industry: electronics (including optics and precise instruments), plastics and metal products.

Identification of the fast growing industries was based on the analysis of the rate of growth in output, employment and export in each of the 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 fast 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 the 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 compared to industries which rely mainly on local markets (Shefer et al., 1998).

The data was collected via field surveys conducted simultaneously in both countries, from a carefully selected sample of firms. In order to conduct the survey, questionnaires were constructed for gathering the data on the firm's level. Data concerning innovation activity, as well as information concerning firm's characteristics such as: ownership type, size, age, R&D activities, etc., was included in the questionnaires

In Israel, personal interviews were held with senior managers in each of the firms included in the sample. In total, 211 industrial firms, from the three selected industrial branches, were personally interviewed. This sample comprised approximately 72% of the firms in the surveyed region, associated with these three industrial branches. In Germany, questionnaires were mailed to approximately 2,800 plants located in the research region - the federal state of Baden Württemberg. 482 plants returned the questionnaires with the requested information, of which 220 came from the three fast growing industrial branches that had been selected.

The fundamental research question is linked to the spatial rate of innovations by the industrial firms in the various sub-regions. For this reason, regions of different types were selected to be included in the study. The two research regions chosen, in the two countries, each encompass three types of sub-regions: metropolitan area, intermediate zone and peripheral zone.

In Israel the Northern part of the country was selected for the analysis. The Northern region is one of the most fascinating regions in Israel in terms of the composition of its residents (Jews and non-Jews, veteran settlers as well as new immigrants), its settlements (type and pattern), and its landscape. In 1995, some 1.4M people, constituting about 26% of the population of Israel, resided in the region, which extends 5,000 sq. km., or 23% of the total land area of the state.

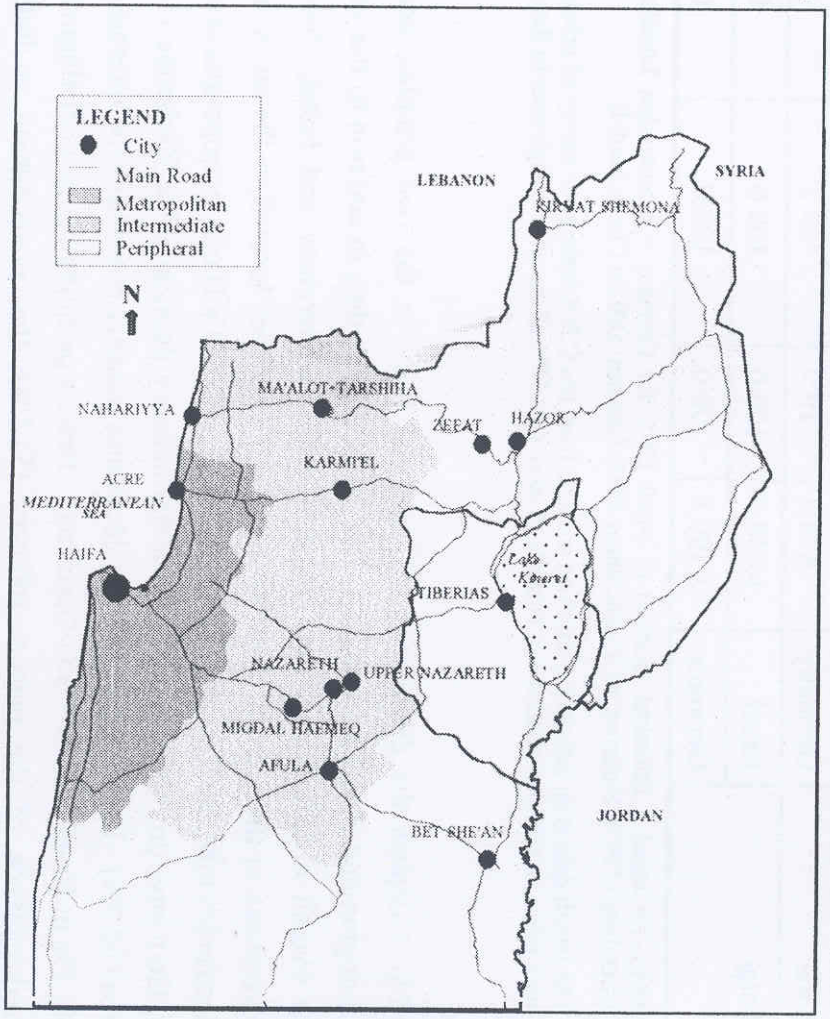
The northern region of Israel was divided into three sub-regions: 1) Haifa Metropolitan Area (central zone). 2) central Galilee (intermediate zone) the areas that surround the Core zones, on the fringe of the metropolitan area, and are within acceptable commuting distance. Although this zone was considered until not too long ago, peripheral, the recent tide of population expansion in the Core zone 'spilled over' into the surrounding areas, bringing about a change in their rate of growth and regional functionality. The northern intermediate region contain the central and west Galilee. 3) Eastern Galilee (peripheral zone) an area that removed from the metropolitan influence, and is not within acceptable

commuting distance. It exhibits most of the classical characteristics of a Peripheral zone, including fewer employment opportunities, as well as fewer social and commercial services. This area consists the Golan Heights, Eastern Galilee and all along the Jordan Valley, from Metula and Kiryat Shamona in the north to B'iet Sh'ean in the south-east (see Map 1a).

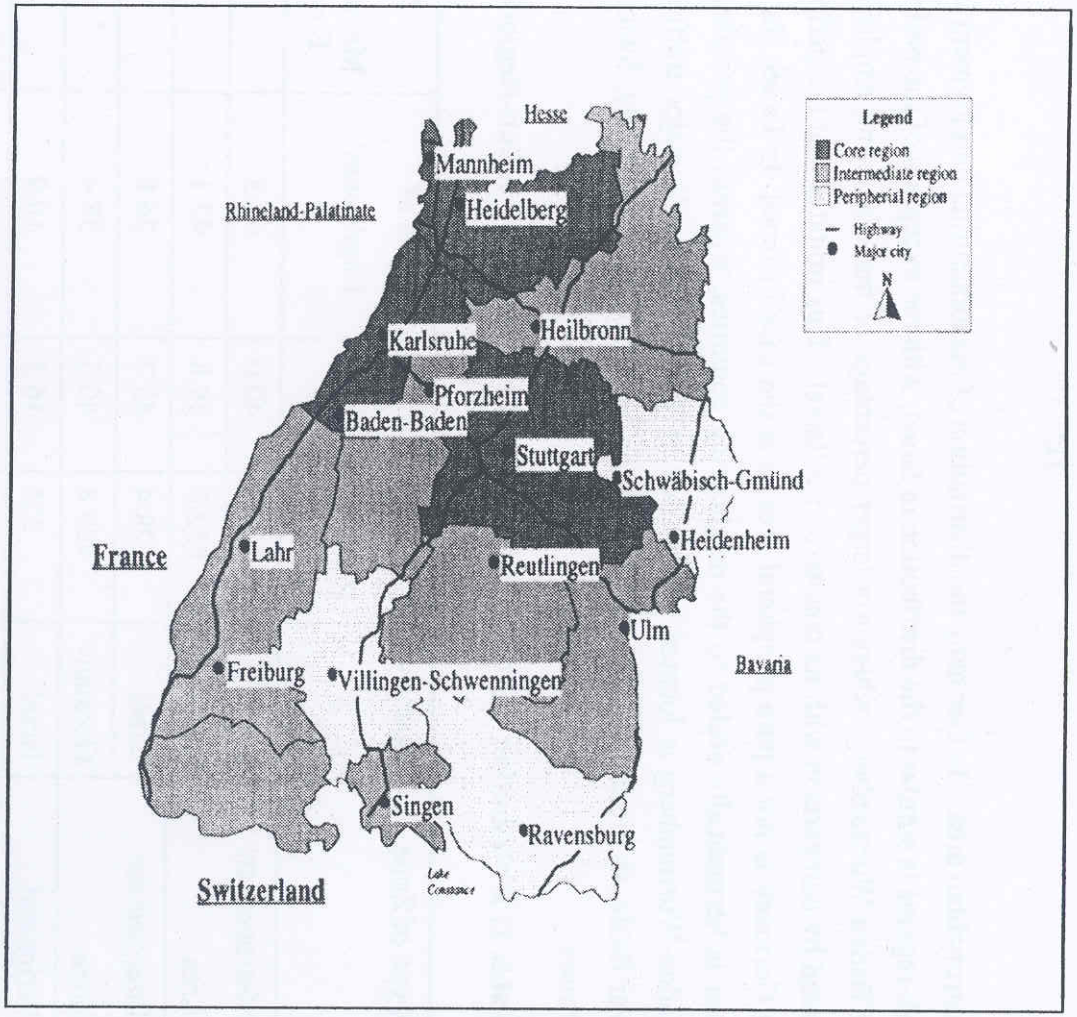
In Germany the investigated areas are part of the federal state of Baden-Württemberg. Baden-Württemberg is one of the industrial regions in Germany. It is characterized by a broad, medium-sized industrial structure and by large internationally operating companies like Daimler-Benz, Porsche and Bosch. Major branches are machinery, electrical and electronic equipment, transport equipment, and metal products. The "Mittelstand" of Baden-Württemberg is seen as the important economical success-factor of this federal state, also named as "model region" (Cooke et al. 1993). Baden-Württemberg consists of 12 planning regions whereas three of them were selected for the analysis (see Map 1b). In 1995 the three planning regions investigated contained 2.4M people, constituting about 23% of the population of Baden-Württemberg. These planning regions represent the 3 types of sub-regions analyzed in the study: 1) Karlsruhe metropolitan area - "Mittlerer Oberrhein" (central area), 2) Südlicher Oberrhein - Freiburg area (intermediate zone), and 3) Schwarzwald-Baar-Heuberg ("peripheral area").

Table 1 depicts comparative on the research region in the two countries. The data shows that the population in the research area in Germany is 1.7 times larger than that in Israel. 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 in the two countries. The data indicates that the Haifa metropolitan area in Israel provides a larger percentage of employment opportunities than does the region of Karlsruhe, its German counterpart. In Israel, the percentage of employees drops sharply and significantly when moving out of the metropolitan area towards the intermediate zone, and from there on to the peripheral area; by comparison, Germany has a more equitable distribution of employment among the sub-areas. In Israel, a more equitable distribution of employment can be seen in the manufacturing industries (see Table 1). This is due to the fact that in recent years the intermediate zone in Israel has been undergoing a transformation, attracting new industrial plants. This trend is reflected in the high proportion of young firms, which have been set up in this sub-region. This phenomenon is linked to the availability of land for the development and expansion of firms, the development of needed infrastructures road and communications systems, and the relative proximity to a large pool of highly skilled labor residing on the outskirts of the

Map 1: Major Arial Division



1a: Northern Region in Israel



1b: States of Baden-Württemberg

metropolitan area. In Germany the distribution of manufacturing employment in the three sub-regions is similar to the distribution in Israel, with the exception of the peripheral zone of Baden Württemberg, wherein a larger percentage of manufacturing employees can be found by comparison with its counterpart in Israel. This imitates that the peripheral zone in Germany is not a pure peripheral area as is the case in Israel. In Israel, the peripheral area is hermetically sealed to the neighboring countries, whereas the peripheral area of Baden Württemberg is located next to one of Western Europe's major traffic junctions, near Basle, in proximity to the open common border between Germany, Switzerland and France.

Table 1: Distribution of Population and Employment Between Sub-Regions in Israel and Germany 1995*

Type of Zone	Country	Population size		% of Employees[1]	% of Manufacturing Employees
		number	%		
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	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: for Israel - Statistical Abstract of Israel 1995, for Germany – Statistisches Landesamt Baden-Württemberg (1997). Statistisches Taschenbuch 1997, Stuttgart: Offizin Chr. Scheufele

1. The Israeli data is an estimation based on analysis from the C.B.S manpower survey of urban settlements with more then 10,000 residents (it consists of more than 70% of the whole employees in the area).

Table 2 depicts the distribution of industrial firms in the two samples, according to sub-region and industrial branch. The data indicates that, in addition to the variations in the overall distribution of the industrial firms in Germany and Israel, there are also differences in the sectoral distribution of the industries located in the study areas. The electronics industries predominate the sample in Israel's Haifa metropolitan area (54.4%). In Germany, on the other hand the metal industry dominates the Karlsruhe metropolitan area (40.7%). In both countries the electronics industry dominates 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%); this phenomenon is linked to the

concentration of kibbutzim in the peripheral area and to the high prevalence of plastics firms in the kibbutz industry. The industry in the peripheral region of Germany's Baden Württemberg State has a polarized branch structure. The plastics industry is significantly limited in this region (only 7.5%) being dominated primarily by the metal industry (50.0%) which is closely followed by the electronics industry (42.5%). It can be assumed that the spatial variations in the regional distribution of these industrial plants in the two countries are likely to impact the rate of regional innovation of each sub-region by type.

Table 2: Distribution of Firms by Industrial Branch, Country and Location (in %)

Industry Type	Countries		Regions					
	Israel	Germany	Metropolitan		Intermediate		Periphery	
			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

4. Innovation Pattern

Many studies distinguish between product innovation and process innovation. During the production life cycle, it becomes increasingly difficult and expensive to innovate and substantially improve new products and services. When this time 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 production processes (Alderman, 1990). Firms adopt process innovation by purchasing it in the marketplace, similar to the purchase of other production inputs. By contrast, product innovation is protected, both structurally and conceptually, since it is a vehicle of gaining superiority of the firm over its competitors.

This study focus on product innovation, thus we defined innovative firms as those firms that have created innovation during the past three years. Included in this definition are activities leading to the development of new products, the adoption of products, which are new to the market, and the substantial improvement of existing products (development of the next generation of products). These activities emanate from in-house investments in R&D, or 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 as innovative firms.

The regional variation of the innovation pattern in Germany and Israel is reflected in the frequency of innovation among the firms located in each of the defined sub-regions.

Analysis of the two samples demonstrated the different locational patterns of firms with respect to innovation, considering their industrial branches. The results suggest that it would be appropriate to examine the impact of the industrial branch on the rate of regional innovation, while categorizing firms into two basic industrial groups on the basis of technological character. The first group represents the hi-tech industries, and it includes the electronics industry, electro-optics, optics, and precision instruments. The second group represents the more traditional industries, and it includes the plastics and metal products industrial branches.

The reasons for this division is also connected to the fact that the number of plants affiliated to the metal products industry in the Israeli sample, and the number of plants affiliated to the plastics industry in the German sample, are relatively small. The similarity in behavior among the traditional industrial branches (plastics and metal products) on the one hand, and the difference between these industries and the hi-tech industries on the other hand, both lend justification to this grouping. Furthermore, numerous variations have been found in the innovative properties characterizing these two industrial groups. This divergence 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 depicts the results of the statistical analyses concerning several selected variables measuring the extent of R&D activities in the firms. The results show that a significant difference exists among the different industrial branches. When a similar analyses has conducted but only between the plastics and metal products – no statistical difference was observed. It is for this reason that we decided to stratify the industries into two major groups – the hi-tech, which includes the electronic industry, and the traditional group which includes the plastics and metals industrial branches.

Innovation development is a prerequisite activity for hi-tech firms. These firms must therefore invest in R&D, including basic research, and are obliged to engage highly skilled labor in order to handle the complex technological problems. By contrast, for the firms in the traditional industries innovation are not as essential, and are chiefly linked to process innovation, aimed at improving and/or adopting new products.

The distribution of innovative firms, when categorized into the two aforementioned industrial groups, demonstrates a strong similarity between the two countries, both in the prevalence of innovation in the sampled firms, and in their regional behavior (see Tables 4 and 5, below). There are a significantly high percentage of innovative firms in the hi-tech industries of both Israel and Germany (77.2% and 74.4% respectively).

Table 3: Labor and R&D inputs, ANOVA between Industrial Groups (in bracket number of observations)

Industrial Groups	% Highly Skilled Labor	% R&D Workers	% R&D Expenditure	R&D Expenditure (M$)
Electronic	25.9 (183)	17.7 (175)	14.2 (170)	2.46 (161)
Plastic	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

By contrast, among firms representing the traditional industries there is a much lower percentage of innovative firms, in Israel and, to an even greater extent, in Germany (49.6% and 36.5% respectively). This difference between the two countries is statistically significant at the 0.05 level.

Table 4: Distribution of Hi-tech Firms by Innovation and Location in Israel and Germany (%)

Innovation	Countries		Israeli regions			German regions		
	Israel	Germany	Metro-politan	Inter-mediate	Perip-hery	Metro-politan	Inter-mediate	Perip-hery
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 (%)

Innovation	Countries		Israeli regions			German regions		
	Israel	Germany	Metro-politan	Inter-mediate	Perip-hery	Metro-politan	Inter-mediate	Perip-hery
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		

The inter-area comparison of hi-tech firms showed no significant differences between the percentage of innovative firms in the two countries. However, the inter-area comparison of innovation by the traditional firms showed a significant difference between the percentage of innovative firms in the two countries. The percentages of innovative firms affiliated to the traditional industries, located in the metropolitan and intermediate sub-regions, are very similar to each other in both countries. By contrast, in Israeli peripheral area there is much higher percentage of innovative firms (almost double the rate) comparable to firms located in the peripheral area in Germany.

An examination of the inter-area variations in each of the countries, as presented in Tables 4 and 5, points to the existence of a trend in regional behavior, with regard to innovation, in the two industrial groups - particularly in Israel, and less so in Germany. In Israel, there is a significant decrease in the percentage of innovative firms in hi-tech industry as one progresses from the metropolitan area to the intermediate zone, and from there, to the periphery. These inter-areas differences are statistically significant (at 0.05 level). A similar decline in the percentage of innovative firms when progressing from the metropolitan area to the periphery has also been observed in Germany; however, the inter-area variations are smaller in Germany (especially between the intermediate and peripheral areas) and not statistically significant. The reverse regional trend has been observed in Israel's traditional industries, where the percentage of innovative firms increases with the movement from the metropolitan area towards the intermediate zone, and from there, to the periphery. These regional differences are of moderate statistical significance. In Germany, the percentage of innovative firms characterizing traditional industries is higher in the intermediate zone when compared with the metropolitan and the peripheral areas; however these differences are not statistically significant.

The impact of the firms' organizational structures on their propensity to innovate is greater in Germany than in Israel. In both countries, the percentage of innovative firms for multi-plant companies is higher than those of single-plant firms (see Table 6). Similar results were obtained also in study carried out in the UK (Geroski and Machin, 1992; Roper and Love, 1996). In Germany, this variation in the percentage of innovative firms is statistically significant, but not so in Israel.

The importance of R&D as a major factor in inducing innovation has been shown in many studies, including this study. The results presented in Table 7 demonstrate the statistically significant relationship existing between the percentage of innovative firms and the firm's R&D activities, as expressed in the number of R&D employees and the expenditure on R&D.

Table 6: Distribution of Firms by Innovation and Ownership Type, in Israel and Germany (%)

Innovation	Israel		German	
	Single-plant	Multiplant	Single-plant	Multiplant
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	

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 in Germany seems to be based more on outsourced R&D services, and less on in-house R&D activity, as reflected in the number of R&D employees in the firm. In Germany, 10.9% of all innovative firms employ no R&D employees at all, compared with only 2.4% in Israel.

Table 7: Distribution of Firms by Innovation and Number of R&D Employees in Israel and Germany (%)

Number of Employees in R&D	Israel				Germany			
	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			

Analysis of the data in Table 8 supports the hypothesis that there exists a statistically significant correlation between innovation activities and expenditures on R&D. The data indicates that most of the German firms who spent on R&D were product innovative, while the rate in Israel is particularly lower in firms with an R&D expenditure of $100,000 per annum or less (only 65%). A large portion of the remaining firms (35%) engaged in process innovation, rather than in product innovation. This latter group was not included in the innovative firms as defined in this study. In general, it may be stated 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.

Table 8: Distribution of Firms by Innovation and Investment on R&D in Israel and Germany (%)

Invesment on R&D (milion $)	Israel				Germany			
	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			

5. Multivariate Analysis

5.1 The models used

The results obtained with the Logit model pointed out the differences existing between the two countries. The Logit model is a binary choice model which assumes that a firm must chose between two alternatives: either to engage in innovation or not. This choice is influenced by the firm's internal attributes such as: branch affiliation, expenditure on R&D, ownership type, size and age of the firm as well as its location and production milieu (Shefer and Frenkel, 1998).

The variables in the model that explain the probability of a firm engaging in innovation are categorized into three types:

a. Basic variables:

Location variable – divided into three sub-regions – metropolitan area, intermediate zone and peripheral area.

Branch affiliation– categorized into two types of industrial groups – hi-tech industries and traditional industries.

b. Firms Attributes:

Firm R&D activity – the assumption is that product innovation is, to a large extent, dependent on the existence of R&D activities. The indices used to measure the scope of this activity are related to the firm's annual expenditure on R&D and to the number of employees engaged in R&D.

Organizational structure – the firms in the samples were divided into two principal groups: multi-plant group, and single-plant group.

Firm age – It is hypothesized that newer firms are more innovative compared with older firms. The age of a firm is a continuous variable, i.e. number of years.

Firm size – Plant size is 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.

c. Production milieu:

The impact of production milieu on the rate of innovation is examined by means of agglomeration indices in the various sub-regions. 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 canceling-out the differences which exist in the geographical size of each sub-region.

We assumed that the agglomeration effect follows an exponential function, therefore the agglomeration index was calculated by squaring the population density variable in each of the sub-regions (Shefer, 1987, also used this method; see also Moomaw, 1983).

The Logit model was applied separately to the two defined industrial groups - the hi-tech industries and the traditional industries. The model was applied while constructing dual-nation models incorporating the sample data of the two countries. These models enabled examination of the impact of each of the above-mentioned variables on the probability of developing innovation. In order to statistically test the differences between Germany and Israel, we introduced a dummy variable. A value of 1 was assigned for the firms in the German sample, and a value of 0 was assigned for the plants in the Israeli sample.

Six of the models used are presented in Table No. 9. Three divisions were used in the analyses of the models. First we classified the models into two exclusive groups: 'a', 'b' and 'c' present the results obtained when applying the data of the firms belonging to hi-tech industries, whereas models 'd', 'e' and 'f' present the results obtained when applying the data of the firms belonging to the traditional industries. Secondly, we have used two alternative measures of R&D activities, based on the hypothesis which stated that a significant positive relationship exists between expenditures on R&D and the rate of innovation. In order to examine this hypothesis, we used separate R&D indices, while the rest of the independent variables in the model remained unchanged. Models 'a' and 'd' include the overall expenditure on R&D, measured as the percentage of the firm's annual turnover. This index incorporated both in-firm expenditures and the expenditures on outsourced R&D services. Models 'b' and 'e' include only expenditures on in-house R&D, measured by means of the percentage of the firm's employees engaged in R&D. It was thus possible to carry out a more sensitive analysis similar to the ones conducted in previous studies (Thwaites, 1982; Oakey, 1984; Davelaar, 1991). Thirdly we have

Table 9: LOGIT Model Results for the Dual-nation Model Analysis (t-value in parentheses)

Independent	High-tech Industries			Traditional Industries		
Variable	Model a	Model b	Model c	Model d	Model e	Model f
Constant	-5.565 (-2.66)*	-4.575 (-3.22)*	-5.932 (-2.68)*	-3.115 (-4.87)*	-4.019 (-5.59)*	-4.087 (-5.25)*
R&D expenditures***	1.225 (4.44)*	0.394 (4.62)*	1.228 (4.48)*	0.161 (3.32)*	0.226 (4.74)*	0.229 (4.79)*
Germany (yes) (1)	3.288 (2.18)*	1.665 (1.79)**	3.878 (2.04)*	———	———	———
Location in Israeli metro-politan area (yes) (1)	2.641 (2.03)*	1.450 (1.60)**	———	-1.120 (-2.06)*	-1.647 (-2.70)*	———
Location in German inter-mediate zone (yes) (1)	———	———	———	0.731 (1.41)	0.913 (1.72)**	0.886 (1.66)**
Size of Firms (large=3, medium =2, small = 1)	0.958 (1.27)	1.272 (2.35)*	0.993 (1.27)	1.050 (3.50)*	1.338 (4187)*	1.364 (4.20)*
Age of German Firms (number of Years)	-0.408E-01 (-1.39)	-0.256E-01 (-1.70)**	-0.434E-01 (-1.41)	———	———	———
Age of Israeli plants (number of years)	———	———	———	0.461E-01 (2.90)*	0.494E-01 (3.01)*	0.558E-01 (3.02)*
Israeli multi-plants (yes) (1)	-0.769 (-0.56)	-0.771 (-0.86)	-0.893 (-0.66)	0.279 (0.23)	0.526 (0.44)	0.646 (0.53)
German multi-plants (yes) (1)	1.646 (1.02)	2.085 (1.65)**	1.670 (1.05)	0.198 (0.34)	0.300 (0.48)	0.218 (0.34)
Index of Isrtaeli Agglomeration	———	———	0.321E-05 (2.00)*	———	———	-0.205E-05 (-2.82)*
Index of German Agglomeration	———	———	-0.379E-05 (-0.33)	———	———	0.982E-06 (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
p^2	0.80	0.66	0.80	0.18	0.24	0.25
$\bar{p}^2$	0.75	0.57	0.75	0.17	0.24	0.24

* Significant at $p<0.05$

** Significant at $p<0.10$

*** In model a, c and d = % R&D expenditures from total revenue; in model b, e and f = % R&D employees.

(1) Dummy Variable, reference group in parentheses

introduced into the two remaining models 'c' and 'f', a new variable which measures the extent of the production milieu. This variable is the agglomeration index (surrogate of the production milieu) which replaces the locational dummy variable included in the previous models. Since a high correlation exists between the locational dummy variables, and the agglomeration index, to avoid multicollinearity and for efficient and reliable estimations, we have decided to include in these two models only the agglomeration index and to exclude the locational dummy variables.

The results obtained are presented in Table 9. The t-values presented in the table indicate the level of statistical significance of each of the coefficient estimated, as well as the direction and scope of the variable's effect. The overall strength of the model is also presented in the table by means of the final likelihood obtained, and the model's overall level of explanation (p^2) given by the independent variables included in the model.

5.2. Empirical results

5.2.1 The Hi-Tech Industries

As anticipated, the results in 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 to the strong and positive effect of this variable (in both countries), the country dummy variable, was also found to be statistically significant. This means that all things being equal, the probability of generating innovation in a hi-tech firm in Germany is slightly higher than 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 the second model (b), we conclude that in both countries the percentage of persons engaged in R&D positively impact the probability of generating innovation. However, significant differences between the countries were found for the other variables. Here too an Israeli hi-tech firm located in a metropolitan area has a statistically significant effect on the probability of generating innovation, although the level of significance is lower here compared to the one obtained in the previous model. In this model, 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 their ability to take risks, more than the small firms.

By contrast, a difference was found between the two countries in the effect of plant age. In Germany, the effect of the firm's age was found to be 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 a very large proportion of Israel's hi-tech firms are young firms established in the late 1970s and the early 1980s, unlike Germany, where the age distribution of the firms is much wider. 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 this variable is statistically significant in Germany, but not so in Israel. In Germany, plants belonging to multi-plant companies are more likely to develop innovation than single-plant firms. The likelihood obtained in the two models discussed above is good, and the level of explanation obtained in both is very high, particularly in the more complete model 'a'.

The results obtained from the application of model 'c' show a statistically significant and strong positive effect in Israel, which the agglomeration variable has on the probability of generating innovation. 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 reinforces even further the conclusion that in Germany, unlike Israel, location has almost no 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 variations obtained in Israel. This is particularly so when we compare between the agglomeration indices calculated for the intermediate zone of Freiburg and the peripheral area of Baden Württemberg. However, the agglomeration index calculated for the metropolitan area of Karlsruhe is double the indices calculated for the two other areas. Yet, despite this fact, this variable in Germany has not been found to influence the probability of generating innovation in hi-tech firms. It reflects the stronger independence of being located in a non-metropolitan region on generating innovation in Germany compared to Israel (Koschatzky, 1997).

5.2.2. The Traditional Industries

The results obtained from applying models 'd', 'e' and 'f' using the data from firms affiliated with the traditional industries, show that there are a number of variables which affect the probability of generating innovation - particularly in Israel, and less so in Germany. The overall level of explanations obtained in these models is less than the one obtained in the hi-tech industries.

Here too the expenditure on R&D variable has a significant and dominant impact on the probability of generating innovation. This impact is positive, and is highly significant

statistically. This is true 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 impact of firm size on the probability of generating innovation. A similar result was obtained for the model using the data from the hi-tech plants.

Differences were found between the two countries with regard to the firm's location. In Israel, it was found that being located in the metropolitan area generally lowered the probability of generating innovation in the traditional industries (the opposite was found for hi-tech industries). It is possible that this statistically significant result, is connected with the fact that most traditional firms owned by kibbutzim (which are located mostly in peripheral area) have a greater tendency to innovate, compared with firms in this sector 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 is in the impact of the firm age on the rate of innovation. It was found that in the traditional industries in Israel (not in Germany), the age effect is positive, and of statistical significance; in other words, the older is the firm, the higher is the rate of innovation. The fact that most of the old innovative firms in this group of industries owned by the kibbutzim may serve as an additional explanatory factor. Most of these traditional firms were set up in the seventies, when many kibbutzim began to undergo some structural change. Industrial jobs were created in order to replace the surplus of workers in agriculture. From the mid-eighties, with the economic crisis suffered by the kibbutzim, fewer and fewer new firms were set up in this sector. On the other hand, in both countries, no impact on the probability of generating innovation was found as a result of the firm's organizational structure.

The results of model 'f' reinforce the conclusions regarding the location impact on the rate of innovation of the firms belonging to the traditional industries. The agglomeration index in Israel shows the negative impact of the metropolitan area. This negative effect is statistically significant. This finding is due specifically to the unique situation in the Israel's northern periphery. In Germany, also, the rate of innovation of the firms in traditional industry was not found to be influenced by the agglomeration index (a result similar to that found in the case of firms belonging to the hi-tech industries). The positive effect of the intermediate zone of Freiburg on the firms' probability of generating innovation is not related to agglomeration index in this area, which is similar to the one calculated for the peripheral area of Baden Württemberg.

6. Conclusion

This paper presents the results of a study, which compared innovative activity behavior of industrial firms on a regional and national level in both Germany and Israel. The analysis utilizes data gathered in the framework of a field survey conducted in both countries, covering more than 400 firms from both the hi-tech and the traditional industries. Unlike many other studies, which did not use a shared database, we were presented with the opportunity to conduct a comparative study, and to better examine the similarities and dissimilarities between innovative behavior in different locations in the two countries.

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

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 study findings demonstrate the positive impact of the size of the 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 hi-tech industry. In Israel, on the other hand, it was found that the age of the firm has 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 firms, which were established in the seventies, mostly owned by the kibbutzim.

The effect of industrial branches on the percentage of innovative firms is varies in accordance with location. In general, no significant differences between the innovative ability of the two countries were detected. In both countries, innovation is more prevalent among the hi-tech firms than among the 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 activities, especially in Israel. The hi-tech firms located in the Haifa Metropolitan area in Israel, with its high agglomeration index, enjoy a particularly high percentage of innovative firms. This significant outcome is apparently linked to the production milieu, in which well-developed infrastructure, as well as economic activities supporting innovation exist. This infrastructure is reflected in the existence of academic institutions and research centers, a concentration of business services, and a large pool of skilled labor, all of which help induce the generation of

innovation. Hi-tech firms located in the metropolitan area engaged more in R&D, and less with production activities. The latter activities are left to the subsidiary plants located in the intermediate zone of the 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 the traditional industries, which have less need for a production milieu as reflected in the high value agglomeration index.

In Germany, no significant locational impact on the propensity to innovate in hi-tech firms was observed. Access to an innovation supporting environment (e.g. universities of Karlsruhe and Freiburg, technical colleges, Fraunhofer institutes, Steinbeis transfer centers) is much less spatially limited than in Israel. The inter-regional variation in the percentage of innovative firms in the state of Baden Württemberg in Germany is not statistically significant. It is possible that the positive effect of the intermediate zone of Freiburg on propensity to innovate in the traditional industries is rooted in historical causes and, as in Israel, is not affected by the agglomeration index. As noted above, the strong and marked impact of the metropolitan area in Israel on the propensity to innovate in hi-tech firms, compared with the decrease in this rate when moving out towards the periphery, does not exist in Baden Württemberg. The reason may be associated with the differing nature of the peripheral areas in the two countries. In Israel, the northern peripheral area is hermetically sealed to the neighboring countries, whereas the peripheral area of Baden Württemberg is located next to one of Western Europe's major traffic junctions, near Basle, in proximity to the open common border between Germany, Switzerland and France. This is most definitely not a sealed peripheral area, and can apparently benefit from the advantage offered by its location. Therefore, the peripheral area in Germany which is not similar in character to Israel's peripheral area, could enjoy a higher rate of technological innovation.

BIBLIOGRAPHY

Alderman, N. (1990). "New Patterns of Technological Change in British Manufacturing Industry", ***Sistemi Urbani***, Vol. 3, pp.287-299.

Alderman, N., and Fisher, M.M. (1992). "Innovation and Technologial Change: An Austrian - British Comparison", ***Environment and planning A***, Vol.24, pp.273-288.

Barkley, D.L. (1988). "The Decentralization of High-Technology Manufacturing to Non Metropolitan Areas", ***Growth and Change***, Vol. 19, No.1, pp. 13-30.

Bertuglia, C.S., Lombardo, S., and Nijkamp, P. (eds.) (1997). ***Innovative Behaviour in Space and Time***. Berlin, Germany: Springer.

Bertuglia, S.C., Fischer, M.M., and Preto, G. (eds.) (1995). ***Technological Change, Economic Development and Space***, Berlin, Germany: Springer.

BfLR (1996). ***Statistics Landesamt Baden-Wuerttemberg 1995***.

Camagni, R. (1984). "Spatial Diffusion of Pervasive Process Innovation". ***Paper presented at the 24th European Congress of the Regional Science Association***, Milan, 28-31 August.

Cooke, P., Morgan, K., Price, A. (1993): ***The Future of the Mittelstand. Collaboration versus Competition***. Regional Industry Research, Dept. of City & Regional Planning, University of Wales: Cardiff.

Davelaar, E.J (1991). ***Regional Economic Analysis of Innovation and Incubation***, Worcester, Great Britain: Billing & Sons.

Davelaar, E.J., and Nijkamp, P. (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.

Davelaar, E.J., and Nijkamp, P. (1992). "Operational Models on Industrial Innovation and Spatial Development: A Case Study for the Netherlands", ***Journal of Scientific & Industrial Research***, Vol. 51, pp. 273-284.

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).

Dosi, G. (1988). "Sources, Procedures, and Microeconomic Effects of Innovation", ***Journal of Economic Literature***. Vol. XXVI, pp. 1120-1171.

Dosi, G. (1984). ***Technical Change and Industrial Transformation***, Hong Kong: MacMillan.

Feldman, M.P., and Kutay, A.S. (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. Berluglia, S. Lombardo and P. Nijkamp (eds.) Berlin, Germany: Springer.

Feldman, P. M. (1994). ***The Geography of Innovation***, London: Kluwer Academic Publisher.

Fischer, M.M. (1989). "Innovation, Diffusion and Regions", Chapter 5, in: Andersson, A.E., Batten, D.F., and Karlsson, C. (eds.), ***Knowledge and Industrial Organization***, Berlin, Heidelberg and New York, Springer Verlag , pp. 47-61.

Frenkel, A. (1997). "Can Regional Policy Affect Firms' Innovation Potential in Lagging Regions?", paper presented to the 37th European Congress of the Regional Science Association, Rome, Italy, 26-29 August.

Geroski, P. and Machin, S. (1992). "Do Innovating Firms Outperform Non-Innovators?, ***Business Strategy Review***, P.79-81.

Grossman, G.M., and Helpman, E. (1994). "Endogenous Innovation in the Theory of Growth." ***Journal of Economic Perspectives***, Vol. 8, No. 1, pp. 23-44.

Grossman, G.M., and Helpman, E. (1991). ***Innovation and Growth in the Global Economy***, Cambridge, MA: MIT Press.

Grossman, G.M., and Helpman, E. (1990). "Trade, Innovation and Growth." ***American Economic Review***, Vol. 80, No. 2, pp. 86-91.

Hoover, E.M., and Vernon, R. (1959). ***Anatomy of Metropolis***, Cambridge, Mass.: Harvard University Press.

Howelles, J.R.L. (1984). "The Location of Research and Development: Some Observations and Evidence from Britain", ***Regional Studies***, Vol. 18, pp. 13-29.

Israel Central Bureau of Statistics (1996), ***Statistical Abstract of Israel 1995***, No. 47, Jerusalem.

Jaffe, A.B. (1989). "Real Effects of Academic Research", ***American Economics Review***, Vol. 79, pp. 957-970.

Karlsson, C. (1988). "Innovation Adoption The Product Life Cycle", ***Umea Economic Studies,*** No. 185, Sweden: University of Umea.

Kleinknecht, A. (1996). ***Determinants of Innovation, London***. Macmillan Press.

Kleinknecht, A., and Tom, P. P. (1991). "Do Regions Matter for R&D?", ***Regional Science***, Vol. 26.3, pp. 221-232.

Koschatzky, K. (1997), "Innovationsdeterminanten im interregionalen Vergleich: Möglichkeiten zur Stärkung regionaler Innovationspotentiale", ***Geographische Zeitschrift***, Vol. 25, pp. 97-112.

Koschatzky, K., and Muller, E. (1997). "Firm Innovation and Region - Theoretical and Political Conclusions on Regional Innovation Networking", Paper presented to the 37th European Congress of the Regional Science Association, Rome, Italy, 26-29, August.

Krugman, P. (1995). ***Development, Geography and Economic Theory.*** Cambridge MA: MIT Press.

Krugman, P. (1991). ***Geography and Trade***, 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.

Malecki, E.J. (1979). "Agglomeration and Intra-Firm Linkage in R&D Location in the United States", ***TESG***, Vol. 70, pp. 322-331.

Malecki, E.J. (1977). Firms and Innovation Diffusion: Examples from Banking", ***Environment and Planning A***, Vol. 9, pp. 1291-1305.

Malecki, E.J. and Nijkamp, P. (1988). "Technology and Regional Development: Some Thoughts on Policy", ***Environment and Planning C: Government and Policy***, Vol. 6, pp. 383-399.

Mansfield, E.J. (1991). "Academic Research and Industrial Innovation", ***Research Policy***, Vol. 20, pp.1-12.

Moomaw, R.L. (1983). "Is Population Scale a Worthless Surrogate for Business Agglomeration Economies?", ***Regional Science and Urban Economics***, No. 115, pp. 525-545.

Nelson, R.R. (1993). ***National Innovation Systems***, New York, Oxford university Press.

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.

Nijkamp, P., and Poot, J. (1997) "Endogenous Technological Change, Long-Run Growth and Spatial Interdependence: A Survey." pp. 213-238. In: ***Innovative Behavior in Space and Time***, Bertuglia, C.S., Lombardo, S., and Nijkamp, P. (eds.) Berlin, Germany: Springer.

Norton, R.D. (1979). ***City Life Cycle and American Urban Policy***, New York: Academic Press, .

Oakey, R.P. (1984). "Innovation and Regional Growth in Small High Technology Firms: Evidence from Britain and the USA", ***Regional Studies***, Vol. 18, pp. 237-251.

Pindyck, R.S., and Rubinfeld, D.L. (1981). ***Econometric Models and Economic Forecasts***, London, McGraw-Hill.

Romer, P.M. (1994). "The Origins of Endogenous Growth." ***Journal of Economic Perspective***, Vol. 8, No. 1, pp. 3-22.

Romer, P.M. (1990). "Endogenous Technological Change." ***Journal of Political Economy***, Vol. 98 (part 2), October, pp. S71-S102.

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.

Roper, S., Ashcroft, B., Love, J.H., Dunlop, S., Hofmann, K.V. (1996). ***Product Innovation and Development in UK, German and Irish Manifacturing***, Belfast , Northern Ireland Economic Research Center.

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.

Shefer, D. (1987). "The Effect of Agricultural Price-support Policies on Interregional and Rural-to-Urban Migration in Korea: 1976-1980", ***Regional Science and Urban Economics***, 17, pp. 333-344.

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

Shefer, D., Frenkel, A., Koschatzky, K., Walter, G.H. (1998). ***Targeting Industries for Regional Development In Israel and In Germany - A Comparative Study***, Working Paper, Israel, The S. Neaman Institute for Advanced Studies in Science and Technology.

Statistisches Landesamt Baden-Württemberg (1997). ***Statistisches Taschenbuch 1997***, Stuttgart: Offizin Chr. Scheufele

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

Suarez-Villa, L. (1993). "The Dynamics of Regional Invention and Innovation: Innovative Capacity and Regional Changes in the Twentieth Century", ***Geographical Analysis***, Vol. 25, No. 2, pp.147-164.

Suarez-Villa, L., and Karlsson, C. (1996). "The Development of Sweden's R&D – Intensive Electronic Industry: Export, Outsourcing and Territorial Distribution, ***Environment and Planning A***, 28 (5), pp. 761-950.

Suarez-Villa, L., and Rama, R. (1996). "Outsorcing, R&D and the Pattern of Intra-metropolitan Location: The Electronic Industry of Madrid. ***Urban Studies***, (UK) 33(7), pp. 1155-1197.

Suarez-Villa, L., and Fischer, M.M. (1995). "Technology, Organization and Export-driven Research and Development in Austria's Electronics Industry, ***Regional Studies***, 29, pp. 19-42.

Suarez-Villa, L., and Han, P.-H. (1991). "Organization, Space and Capital in the Development of Korea's Electronic Industry, ***Regional Studies***, 25, pp. 327-343.

Suarez-Villa, L., and Han, P.-H. (1990). "The Risk of Korea's Electronic Industry: Technological Change, Growth and Territorial Distribution, ***Economic Geography***, 66, pp. 273-292.

Sweeney, G.P. (1987). ***Innovation, Entrepreneurs and Regional Development***, London: Frances Pinter.

Taylor, M. (1987). "Enterprise and the Product Life Cycle Model: Conceptual Ambiguities", in: G.A, Van der Knaap and E., Wever (eds.), ***New Technology and Regional Development***, London: Croom Helm, pp.75-93.

Thwaites, A.T. (1982). "Some Evidence of Regional Variations in the Introduction and Diffusion of Industrial Products and Processes Within British Manufacturing Industry", ***Regional Studies***, Vol. 16, pp.371-381.

Thwaites, A.T., Oakey, R.P., Nash, P.A. (1981). ***Industrial Innovation and Regional Development***, Final Report To the Department of Trade and Industry and the Commission of the Eeropean Communities, Center for Urban and Regional Development Studies, University of Newcastle Upon Tyne.

Vernon, R. (1966). "International Investment and Institutional Trade in the Product Cycle", ***Quarterly Journal of Economics***, Vol. 80, pp. 190-207.