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TARGETING INDUSTRIES FOR REGIONAL DEVELOPMENT IN ISRAEL AND IN GERMANY - A COMPARATIVE STUDY

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Chapter 13

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

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Abstract

Economic growth is driven to a large extent by technological progress and innovation. It is therefore essential for effective public policy to identify innovative industries so that policy makers will be able to target government incentive programs toward this specific group of industries. In the present study we assumed that innovation is more prevalent among fastest-growing industries. Thus, the major objective of the current study was to develop a methodology to identify this specific group of industries. Furthermore, we hypothesized that within the fastest-growing industries the high-technology (electronic) firms are by far more innovative than the "traditional" (plastic and metal) firms. The findings corroborate our hypothesis that fastest-growing industries are highly innovative. Moreover, high-technology firms have a significantly greater probability of engaging in innovation than the more traditional firms. These findings could assist in the design of effective public policies aimed at inducing regional innovation.

1. Introduction

This paper reports the results of the first stage of a larger comparative study concerned with the spatial diffusion of innovation in selected manufacturing industries in Germany and Israel and its effect on regional economic growth. (See also Koschatzky et al., 2000, 2000; Frenkel et al., 2000.) The assumption is that the engine for economic growth rests on technological change and innovation (Schumpeter, 1934; Dosi, 1988). In recent years, researchers have become

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increasingly aware of the role of industrial innovation and the impact of its diffusion processes on regional development and economic growth. Since economic growth is driven to a large extent by technological progress, it is paramount for effective public policy that decision-makers understand the process by which industry engages in innovation activities (Schmookler, 1966; Freeman, Clark, and Soete, 1982; Freeman and Soete, 1997; Nelson and Winter, 1982; Frenkel and Shefer, 1997).

The contribution of innovation to regional economic growth has been widely discussed in the literature (Grossman and Helpman, 1991b; Segerstrom, 1991; Barro and Sala-i-Martin, 1995). New economic activities, market expansion, and technological adaptation usually accompany regional development, or the development of a location where technological innovation takes place. Regions with a high level of innovation have become a destination for highly skilled labor and an impetus for improved social and physical infrastructures. From a technological point of view, advanced economic activities tend to possess a high market value, resulting in a competitive advantage at least during the first stage of the diffusion process. Thus, these regions enjoy at times unique opportunities for the development of new firms, the expansion of their market share, profitability, and employment growth. Moreover, regions that are characterized by a high level of technological innovation will show a greater acceleration of economic growth than other regions (Thwaites, Oakley, and Nash, 1981; Davelaar, 1991; Feldman, 1994; Bertuglia, Fischer, and Preto, 1995; Bertuglia, Lombardo, and Nijkamp, 1997; Shefer and Bar-El, 1993).

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. Thus, the major objective of the current study is to develop a methodology and apply it in the process of identifying the group of fastest-growing industries. We assume that innovation is more prevalent in that group of industries. Furthermore, we hypothesized that within the fastest-growing industries the rate of innovation in the group of advanced high technology (electronics) firms far exceeds that of the more "traditional" (plastics and metals) firms. 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.

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 (Aghion and Howitt, 1998; Romer, 1990, 1994; Grossman and Helpman, 1991a, 1994). This new development was contrary to the neoclassical model of growth theory espoused by Solow (1956, 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, Graham, and Markusen, 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, Kelley, and Gant, 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 research and development (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 assume that innovation is more prevalent in the fastest-growing industries than in the slower-growing industries. Furthermore, we hypothesized that 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 randomly selected a sample of firms from which data was collected and subsequently used in our comparative analysis of the rate of innovation patterns in firms.

2. 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 Germany and Israel. We first classified all industrial branches according to rate of growth with respect to production output (measured by revenue) 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 was 1987-1992. An examination of the growth rates of industries during that period was based on the following four indices:

(1) Change in the industry's production output, (measured by total annual revenue);

(2) Change in the industry's number of employees;

(3) Share of the industry's export in total annual revenue; and

(4) Change in the industry's export share from total annual revenue.

The first two indices are concerned with the relative position of each industry independent of its export performance; they identify the growth trend of each industry as indicated by the rate of growth in both indices (change in the number of employees and change in production output). The two indices are also used 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 (Lucas, 1988; Grossman and Helpman, 1990a, 1991b). 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 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 (Stokey, 1995; Segerstrom, 1991).

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 percent 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:

(5) Change in the number of employees engaged in R&D;
(6) Change in the total expenditures on R&D; and
(7) R&D intensity (percentage expenditure on R&D of total revenue).

3. 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 are 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

[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.
[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	Textiles	63	Textiles
14	Clothing and made-up textiles	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
		31	Structural metal products (incl. railroads)
		38	Tools, finished metal products
24	Machinery	32	Mechanical engineering
25	Electrical and electronic equipment	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	Nuclear material
		37	Precision and optical instruments
		39	Musical instruments, toys, etc.

percentage to the production output of the metal products industry or even to the transport equipment sector. Thus this minor difference is tolerable.

4. 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 percent in Israel and almost the same in Germany (16.9 percent). The growth in the number of employees was 7.6 percent in Israel and only 4.0 percent in Germany. A comparison of each industrial branch to the average

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

		Increase in industrial production (%) 1987-92		Increase in the number of employees (%) 1987-92		% of employees			
						Israel		Germany	
Code	Major Industrial Branch	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	Textiles	11.6	−7.7	−21.5	−14.4	4.9	3.6	3.1	2.6
14	Clothing and made-up textiles	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[a]	14.0	15.4	5.5	2.2			86.0	84.6

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

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 beverages, 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 group, we maintain, indicates competitive advantage and thus could be long lasting, whereas the latter represents merely a 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 percent, and the increase in the number of employed workers was only 5.5 percent.

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

(i) A need to close the gap between the west and the east with respect to the consumption of durable and consumer goods;

(ii) An increase in the demand for housing, thus affecting the construction industry;

(iii) A production boom in wood and its products; and

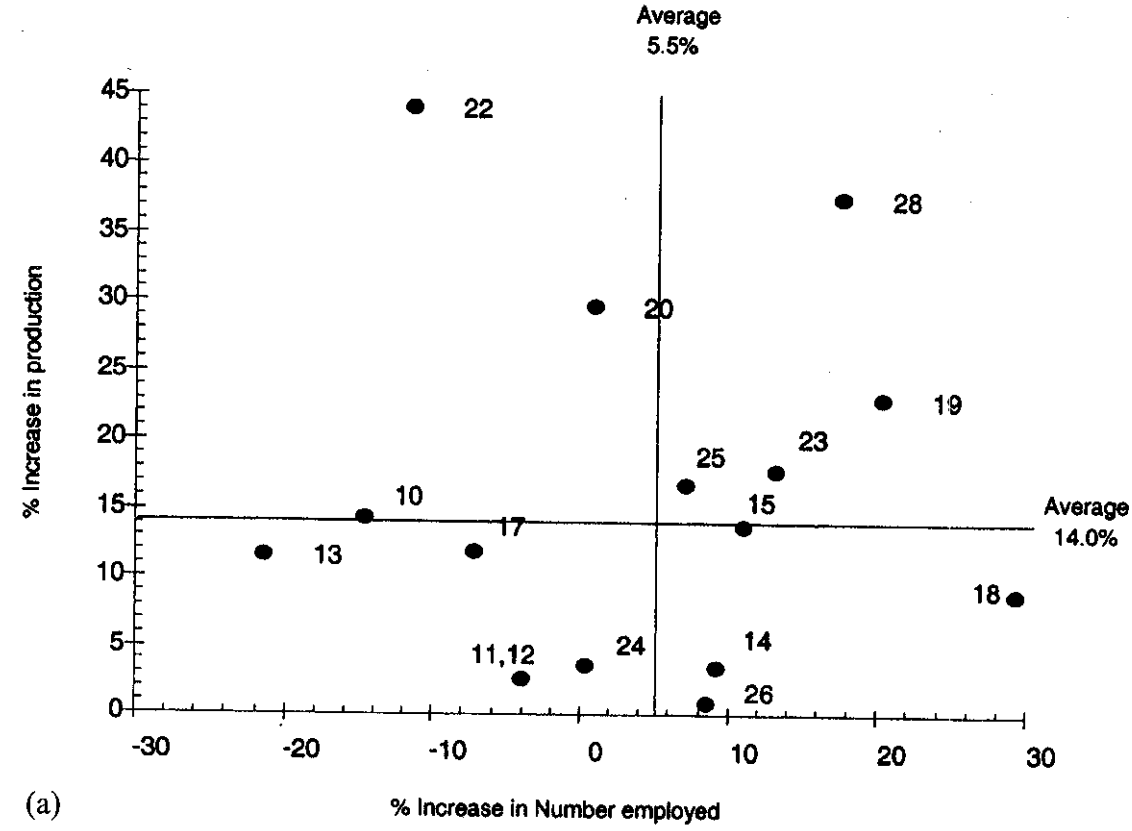
(iv) The urge to compensate for decades of repressed information needs (print media).

In the two periods, 1987-1989 and 1989-1992, the rate of production of food, beverages, and tobacco had increased in Germany by 5.8 percent and 23.2 percent, respectively; and for wood and its products, by 12.2 percent and 17.3 percent, respectively. These growth rates would thus appear to be caused by the first shock of the reunification. The large amount of cash transferred from the 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 these exclusions, the total growth in production outputs, as shown in Table 2, amounted to only 15.4 percent, and the total increase in employment only 2.2 percent in Germany.

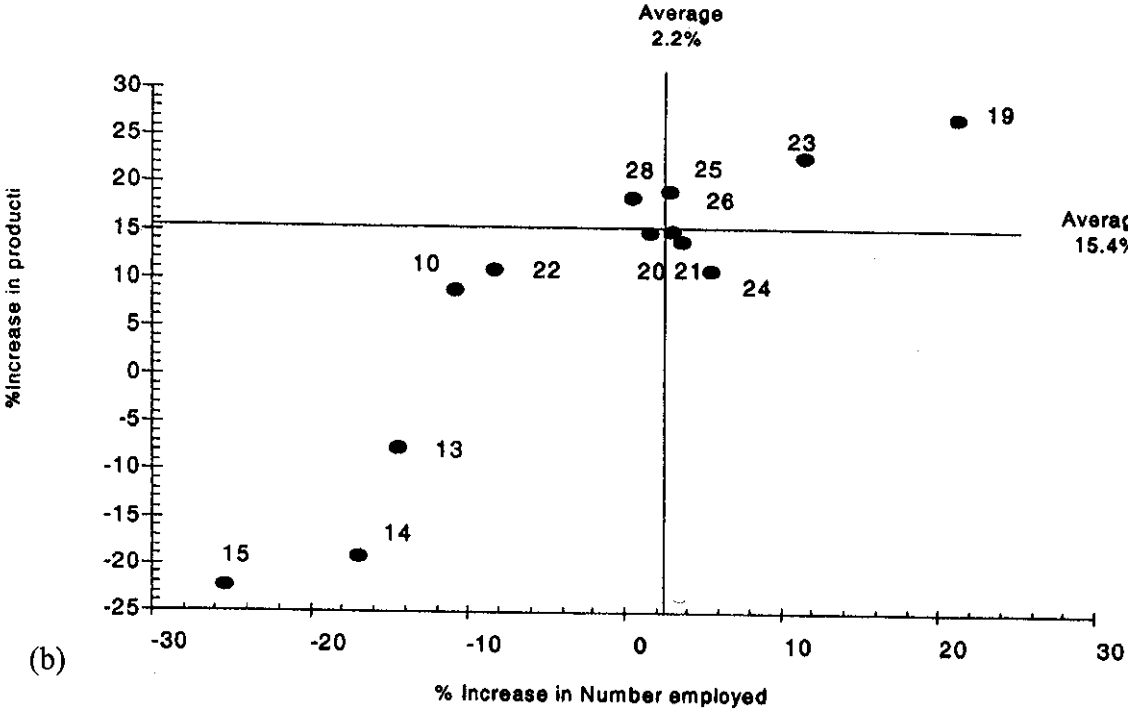
Figures 1a and 1b depict, for Israel and Germany respectively, the distribution of industrial branches on a two-dimensional diagram. The horizontal axis delineates the change in the number of employees during the period from 1987-1992, and the vertical axis the change in production outputs. The results 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, labeled the fastest-growing industrial branches, are: 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 category grew above the average only in production.

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 textiles (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 oil 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 employees.)



(a)



(b)

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

5. Export performance

Export is a determining factor for growth in both countries' economies. Export performance reflects 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.

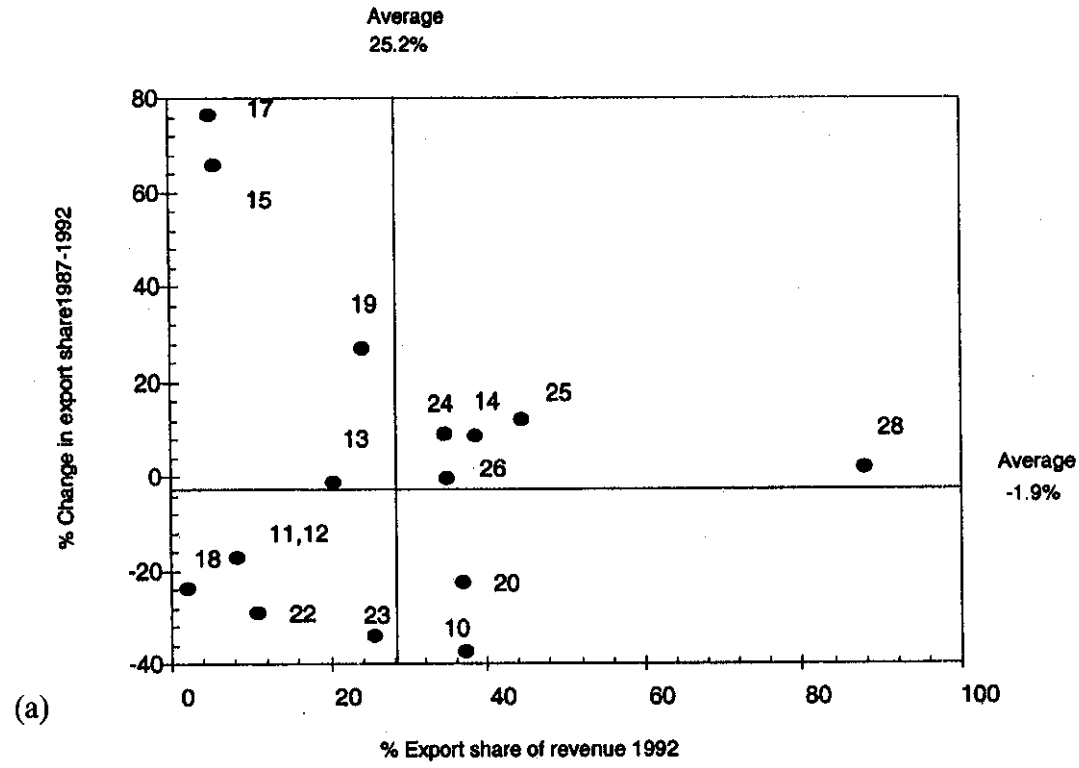
Two indices were used to measure the extent of exports: (1) the export share in an industry's total turnover was used to differentiate between export-led industrial branches and industrial branches that rely mainly, or only, on the local market; (2) the change in an industry's export share that occurred during 1987-1992. 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

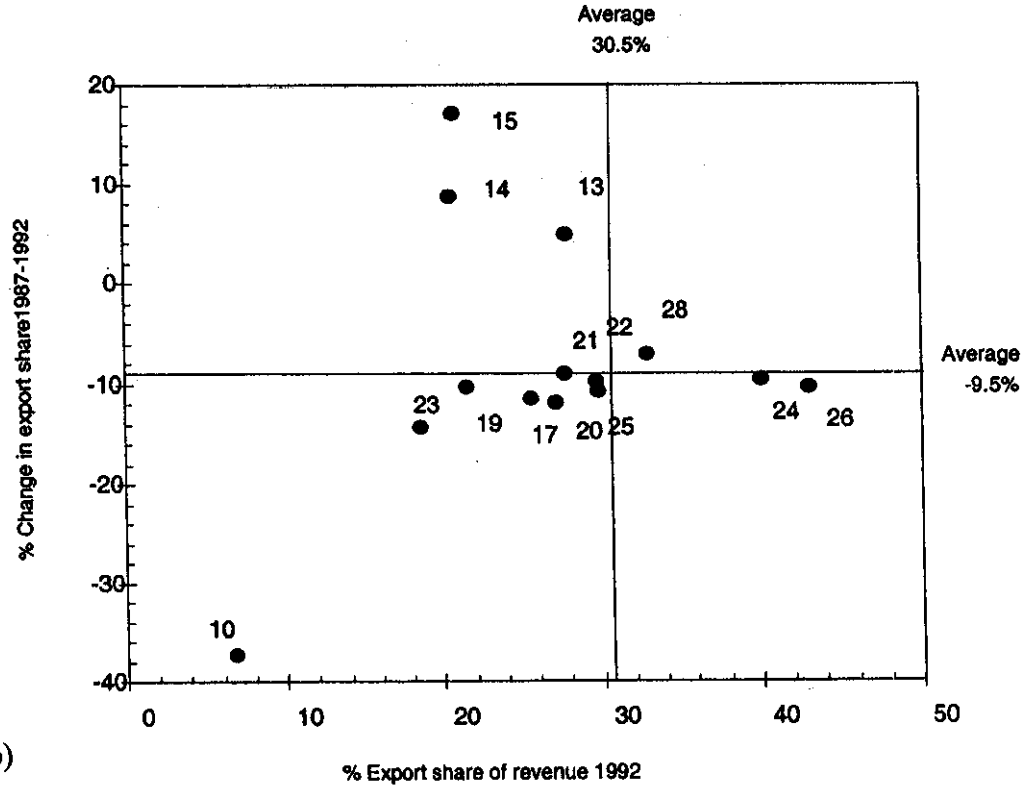
Table 3: Export Share and Its Change, 1987-1992

		Export share of total revenue (%) 1992		Change in export share (%) 1987-92	
Code	Major Branch	Israel	Ger.	Israel	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	Textiles	20.3	27.8	−1.2	5.0
14	Clothing and made-up textiles	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[a]	27.0	30.5	−0.7	−9.5

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



(a)



(b)

Figure 2: Distribution of Industrial Branches According to Their Export Performance (a) in Israel (Excluding Wood and Non-metallic Mineral Products). (b) in Germany (Excluding Food, Wood, Paper and Printing)

percent), 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 percent (excluding food, beverages and tobacco, wood and its products, paper and its products, printing and publishing); however, this share decreased by approximately 9.5 percent overall during 1987-1992.

The distributions in Figures 2a and 2b enable us to identify the outstanding exporting industrial branches and those sectors that produce 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 percent)—electric and electronic equipment (25), clothing and textiles (14) and machinery (24). In all of these industrial branches, the export share amounted to 35–44 percent. 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 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 (24) and transport equipment (26) 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 percent of all industrial employees in Israel. Miscellaneous (28) and rubber and plastic products (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 products industries showed an accelerated increase in export share during the 1987-1992 period.

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

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	Textiles	❖	□	❖	❖	□	□	❖	❖
14	Clothing and made-up textiles	□	❖	□	□	□	□	❖	□
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 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% Israel > 5% Germany

rubber and plastic products (19)] are large industries, employing altogether 53.3 percent 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), and
miscellaneous (28).

The first three 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. However, because of its character, this industry was combined with electric and electronic equipment. These fast-growing industries are shaded in Table 4.

6. 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, and printing and publishing.

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 percent average increase between 1987 and 1992, and an even larger growth in expenditures on R&D, 85 percent, 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

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	
		Israel	Ger.	Israel	Ger.	Israel	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.

percent. In addition, there was a reduction of 3 percent 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 percent, while it was only 2.8 percent for Israel. In almost all industrial branches, German R&D intensity is found to be higher than Israeli R&D intensity; an exception was electrical and electronic equipment, which had identical figures of 7 percent.

In 1992, the four selected fastest-growing industrial branches together accounted for about 30–34 percent of all R&D employees and R&D expenditures in Germany, and for more than double that in Israel (68–71 percent). 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 percent) 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.

7. Analyzing the rate of innovation

Following the methodology developed in this paper, a random sample of over 400 firms belonging to the electronics, plastics, and metals industries was

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

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

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.[3]

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

Table 6 presents the results of the null hypothesis test, which states that there is no difference in the rate of innovation between Israel and Germany in high-tech and traditional firms. As can be seen from the statistical results, there is no significant difference among the rates of innovation in the group of high-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 high-tech and traditional firms within each country. As can easily be

[3] The emphasis here is 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.

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

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

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 high-tech firms was found to be statistically and significantly higher than that found in the traditional firms.

8. 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 and explain the rate of innovation.

Our working hypothesis is 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-technology 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.

We further hypothesized that high-technology firms are more innovative than traditional firms. The findings from our statistical analysis support that

hypothesis. We believe that the results obtained in this study could assist policy-makers in designing effective public policy aimed at inducing regional innovation.

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