Interdisziplinäres Institut für Raumordnung

Stadt- und Regionalentwicklung

Wirtschaftsuniversität Wien

Vorstand: o.Univ.Prof. Dr. Walter B. Stöhr

A-1090 Wien, Augasse 2-6, Tel. (0222) 31 336/4777

1991

Walter B. Stöhr, Richard Pöninghaus

The Effect of New Technological and Organizational Infrastructure on Urban and Regional Development

The Case of the Japanese Technopolis Policy

IIR-Discussion 45 1991

Publikation gefördert durch das
Bundesministerium für Wissenschaft
und Forschung, Wien

THE EFFECT OF NEW TECHNOLOGICAL AND ORGANIZATIONAL INFRASTRUCTURE ON URBAN AND REGIONAL DEVELOPMENT- THE CASE OF THE JAPANESE TECHNOPOLIS POLICY*

Walter B. STÖHR and Richard PÖNIGHAUS†

Paper to be given to the 31st European Congress of the Regional Science Association, Lisbon, August 27 - 30, 1991
1st preliminary draft version - Not to be quoted.

Abstract

Japan has undertaken the unique effort of a concerted nation-wide policy for the decentralisation of technological innovation and territorial restructuring. The major strategic effort towards this end was the Technopolis policy formulated in 1983 in the context of which, during the following five years, 25 decentralized "Technopolises" were established over the entire length of the country.

These Technopolises essentially provide new technological and organizational infrastructure in deconcentrated, sometimes even peripheral locations to promote technological innovation and urban/regional growth also in more remote parts of the country.

The present paper sets out to evaluate the local and regional effects of this policy, on the basis of disaggregated time-series data of local and regional economic performance before and after the establishment of individual Technopolises. These data refer to total new plant and new high-technology plant formation in individual Technopolises, to changes in production (shipments), value-added, productivity and employment at the local and Prefecture levels. These data are related to number and type of specific technological and organizational facilities offered by individual Technopolises as well as to other variables proceeding from an original survey of 25 Technopolises undertaken by the senior author.

The results are based on research and field work undertaken by the senior author in the course of two extended sojourns in Japan during the past years.

*Institutional support is especially acknowledged, on the Japanese side, by: the Japan Society for the Promotion of Science which supported two sojourns of the senior author in Japan, by Gakushuin University in Tokyo which generously hosted him, by the Japan Industrial Location Center, MITI, and all Technopolis administrations for sharing information and data; on the Austrian side by the Ministry of Science and Research for travel support to Japan and part of the cost of data analysis. Acknowledgement to the numerous individuals who through their active support and interest have contributed to this study is made in the text (especially p.4)

†W.B. Stöhr is Head of the Interdisciplinary Institute for Urban and Regional Studies (IIR), R. Pönighaus Research Associate at the Institute of Information Processing and Information Economics, Department of Applied Computer Science, both of the University of Economics and Business Administration, Augasse 2-6, A-1090 Vienna, Austria.

Contents

List of Figures

1 Introduction

One of the interesting aspects of Japan's technology policy is that it is closely related to its regional policy. Two important phases characterize the spatial dimension of Japan's technology policy (Kawashima and Stöhr, 1988):

In 1970 the National Science City Tsukuba was founded about 70 km to the NE of Tokyo. In the first instance a university and a number of governmental research institutes were transferred from Tokyo to Tsukuba, while in the second instance attempts were undertaken to also attract high technology industry in the context of the "Techno-Linkage-Plan" and the Tokodai Research Park. Although not formally designated as such, Tsukuba Science City can be considered a centralised Technopolis at the national level.

In 1983, as a second policy phase, a regionalized technology policy was introduced by the Technopolis Law enacted in that year (Kawashima 1985, Stöhr 1986b, Tatsuno 1986, Kawashima and Stöhr, 1988). The objectives of Japan's Technopolis policy were both national technological ones and regional ones (Stöhr, 1986b): The national technological objective was to offer to high-technology industries adequate industrial land, water and environment suitable for creative research, factors which had become extremely scarce in the major metropolitan areas of Japan; the regional technological objective was to promote technological development also in less developed and more remote areas of Japan. For the latter purpose physical, scientific but also institutional infrastructure in the broader sense was to be developed in decentralized form by a combination of measures taken at the local and Prefecture levels and by national government (especially MITI). Physical infrastructure consisted mainly in adequate transport (air and rapid train) and communications facilities, scientific infrastructure in specialized R&D centres and the active participation of local universities, while institutional infrastructure focused on the establishment of an Innovation Promotion Organization and an Institute for Applied Industrial Research to be set up by local and Prefectural agents in each Technopolis. This organizational infrastructure was of the type called "third sector" in Japan, i.e. by a cooperation of local government, local business and local universities. This package of measures was the basis for the emergence of what could be called "regional innovation complexes" (Stöhr, 1986a).

In the five years following the establishment of the Technopolis Law, 1984 - 1988, a series of 25 Technopolises were established (figure 1). The initial principle was that each Prefecture could establish one Technopolis[1] under the mentioned law and by 1988 about every other of the 47 Japanese Prefectures had established a Technopolis. Metropolitan areas were not eligible for Technopolis status.

2 Technopolis Policy as a Response to the Spatial Concentration of Private R&D

An important reason for the passing of the Technopolis Law was the high degree of spatial concentration of private R&D in Japan. For the period 1981/82 it has been shown that R&D units of private firms were spatially much more concentrated - mainly around the two major metropolitan areas of Tokyo and Osaka - than R&D units attached to government agencies and than university faculties of engineering and science as important bases of R&D (MITI, 1982, Stöhr 1986b). This led to the hypothesis that there were lacking links between the public and the private spheres in this respect. At the national level the Japanese government had already successfully established a close interaction between public and private industrial research. This manifested itself e.g. in numerous specialized industrial research programs operated on a public/private partnership basis, in Japan often called "third sector", and abroad often labelled "Japan Inc". Similar processes were now to be triggered in a spatially deconcentrated form and Technopolis policy became the

[1] This restriction was relaxed later and the largest Prefecture, Hokkaido, could establish a second Technopolis in 1989, which is not any more included in this analysis, however.

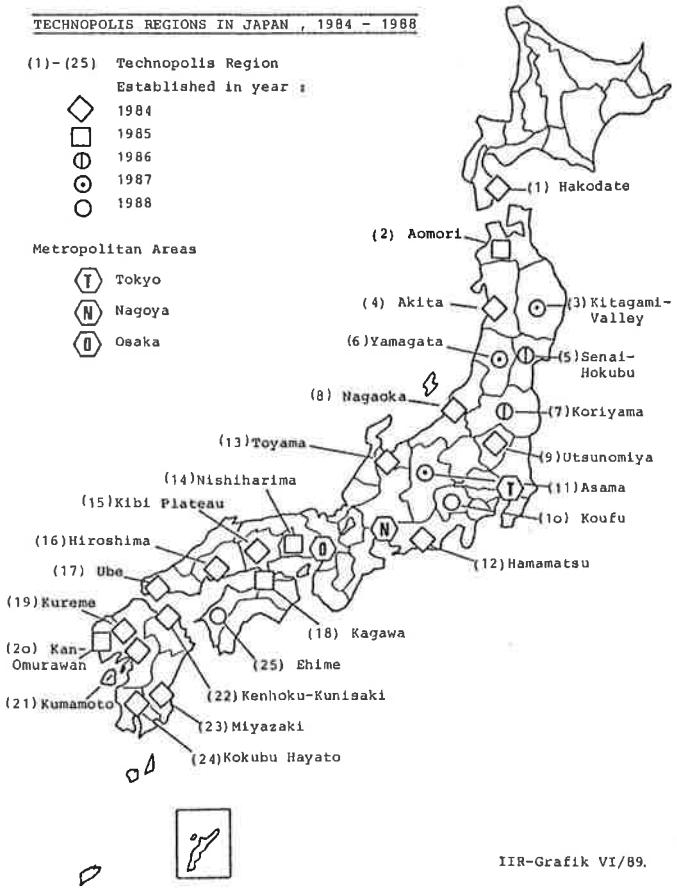

Figure 1: Map: Technopolis Regions in Japan, 1984-1988

framework for it. Details of the policy formulation have been described earlier by this author (Stöhr, 1986b, Kawashima and Stöhr, 1988).

Subsequent to the passage of the Technopolis Law (1983) the largest number of 14 Technopolises was established in the following year 1984 (map 1) followed by much smaller numbers in each subsequent year. As 1984 forms the middle of the time series of data available (1980 - 1989) it offers a good possibility for comparing performance before and after establishment of individual Technopolises.

3 Objectives and Data of the Present Analysis

Most of the writing on Japanese Technopolis policy and its development so far has been based on declarations of intent and verbal announcements of Japanese authorities, often complemented by a (frequently subjective) interpretation of oral communications and visual impressions by foreign visitors. Written data released by Japanese authorities (particularly MITI) on Technopolis development typically were only aggregate ones, usually either time series for the sum of all Technopolises, or for individual Technopolises aggregated over time, or giving only "examples" of specific strategic industrial sectors for each Technopolis, specific industrial research centres, resources designated for specific projects etc. (cf. also Kawashima and Stöhr, 1988). The present senior author was given to understand that one of the reasons for not releasing more disaggregated data was their potential high sensitivity particularly in local elections where the merits of a Prefectural governor (the majority of which belonged to the governing Liberal Democratic Party) were often assessed by the success of the respective Technopolis. Through the generous help of numerous Japanese colleagues, friends and institutions, the present senior author was finally able to assemble a data set of important variables, disaggregated by Technopolis and year for the period 1980 - 1988 resp.

1989 (remaining data for 1989 should be forthcoming soon). These data refer to

- new plant formation per Technopolis for the years 1981 - 1989, in total and for eight specific "high technology" sectors designated by MITI (pharmaceutical products, communications equipment, computers and peripherals, electronical equipment, electrical measurement machines, electrical equipment parts, medical instruments, optical instruments).

- data per Technopolis on:

  - manufacturing shipments
  - value added
  - employment
  - value added/employee (= productivity)

  for the years 1980-1988.

Corresponding data could be secured at the Prefectural and national levels for comparative purposes (Source: Census of Manufactures, MITI). Although data on additional variables would no doubt have been desirable, under existing conditions already the release of these data must be gratefully acknowledged.

Furthermore, the present senior author was able to spend two extended sojourns in Japan in 1984 and 1988. During the latter stay he could implement an extensive written survey of all Technopolises which was kindly sponsored by his host, Professor T. Kawashima of Gakushuin University, Professor Y. Miyakawa of Nagoya Educational University and by Professor N. Sakashita of Tsukuba University. He was further able to visit and make personal interviews at a number of Technopolises through the kind mediation of Professor Miyakawa, and Mr. Ohara of the Japan Industrial Location Centre. It must be stressed that without the extremely kind help of the aforementioned and many other Japanese colleagues and friends the present analysis would not have been possible. As in many other respects, access of outsiders to Japanese resources depends very highly on the availability of well-known Japanese mediators.

In analyzing the above data, these were some of the questions addressed:

- How did new plant formation and that of high-tech plants in Technopolis areas change after Technopolis establishment compared to before?

- How were these newly established plants distributed between more accessible and more remote Technopolises? Was there a marked difference in the performance of larger as against smaller Technopolis areas (urbanization economies or diseconomies, mobilization of resources in small labour markets)?

- Which effect did interregional (particularly transport) infrastructure have on Technopolis development?

- What was the effect of local technological and organizational infrastructure on new plant and new high-tech plant formation in Technopolises?

- Has Technopolis policy led to a major transformation of the spatial development and innovation surface of Japan, i.e., could it contribute to a major deconcentration of new plant formation and of high-technology plants in a national context?

- How did Technopolis areas perform compared to the Japanese metropolitan areas and to national performance as a whole?

- How did Prefectures with a Technopolis perform compared to Prefectures without?

4 Analysis of New Plant Formation in Technopolis Areas

The *annual total of new plant formation*[2] during the observation period 1981-89 in areas which in the years 1984-88 were designated as Technopolis rose steadily and, particularly since 1984, when the first Technopolises were established, exceeded the national average (figure 2). The establish-

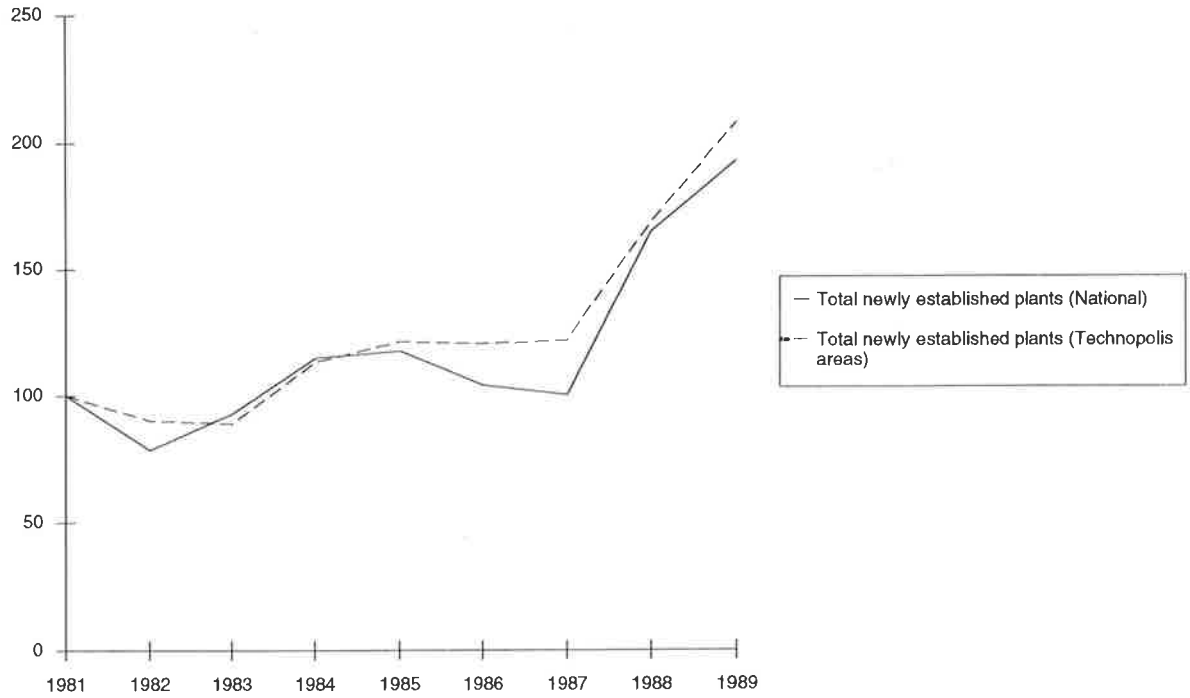

Figure 2: Total annual new plant formation in technopolis areas and in Japan 1981-1989 (1981=100)

ment of new high-tech plants in these areas exceeded the national trend substantially for all years of the observation period, i.e. already before the establishment of Technopolises (figure 3). This seems to indicate that while total new manufacturing plant formation was triggered with the spurt of Technopolis foundations in 1984 and remained high, new high-tech plant formation only had an ephemeral though short boost in that year to oscillate in subsequent years parallel, though still substantially above, the national trend. This might stand for a **slight but sustained general industrialization thrust** at the beginning of Technopolis policy, and at least **a strong announcement effect on new high-tech plant formation** during the first two years of Technopolis policy. The latter is also confirmed by the short-term rise in the high-tech share of new plant formation in Technopolis areas (figure 4).

If one differentiates *by accessibility of Technopolises to Tokyo* however, it turns out that, for the aggregated observation period 1981-89, the high-tech share rose with accessibility to Tokyo (figure 5). For the period as a whole this still indicates the relative concentration of high-tech growth close to Tokyo. When comparing the high- tech share before and after the establishment of Technopolises (figure 6), however, it shows that in peripheral Technopolises (lowest accessibility range from Tokyo) the high-tech share of new plants increased noticeably after the establishment of Technopolises while in all other accessibility ranges it declined (though from higher starting levels). This would seem to indicate that the **establishment of Technopolises particularly in the peripheral areas of Japan has increased the high-tech share of new manufacturing**

[2] In the following analysis we shall distinguish between total new plant formation and that in specific high-technology sectors listed in the previous section (p.4)

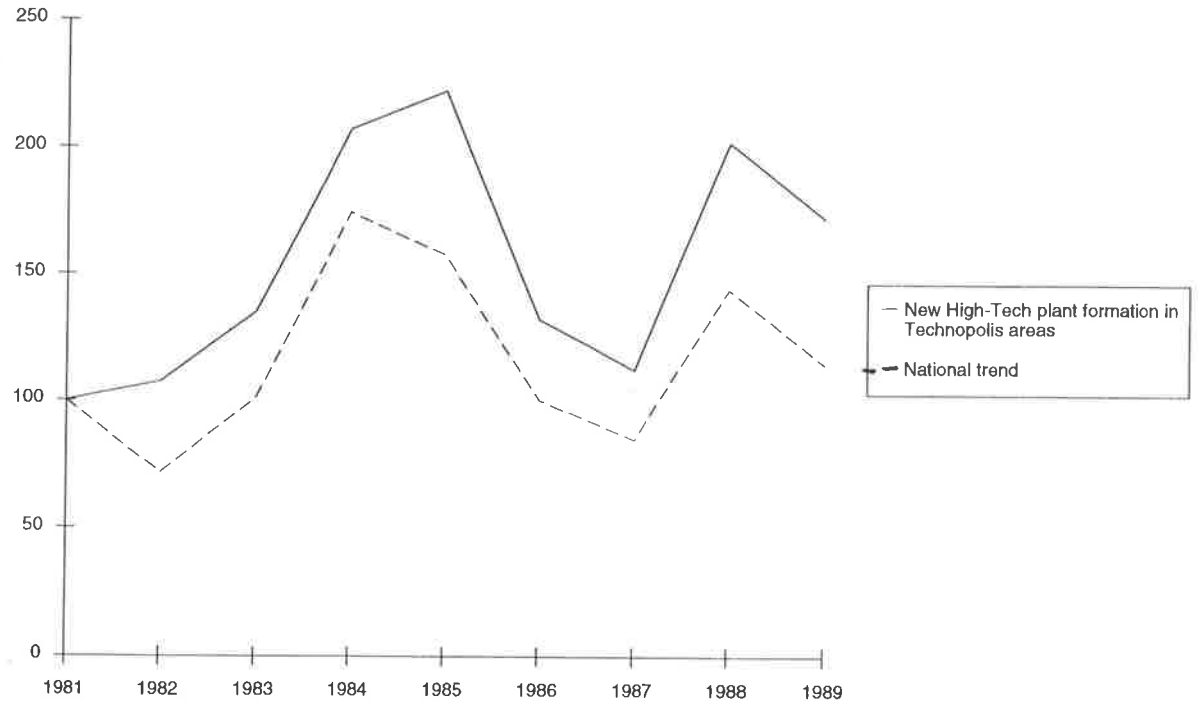

Figure 3: Annual new high-tech plant formation in technopolis areas and in Japan 1981-89 (1981=100)

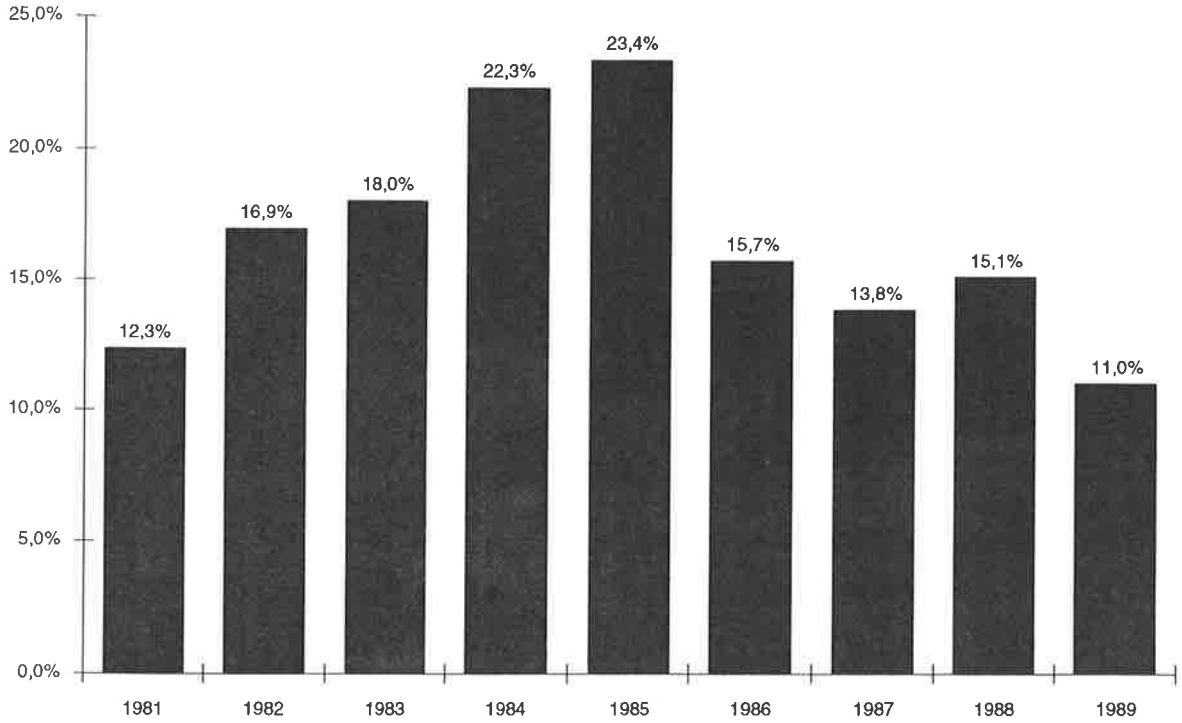

Figure 4: High-tech share (weighted aggreg.) of new plant formation in TP areas (1981-89)

plants and thereby **reduced the strong spatial disparities** which had existed in this respect before.

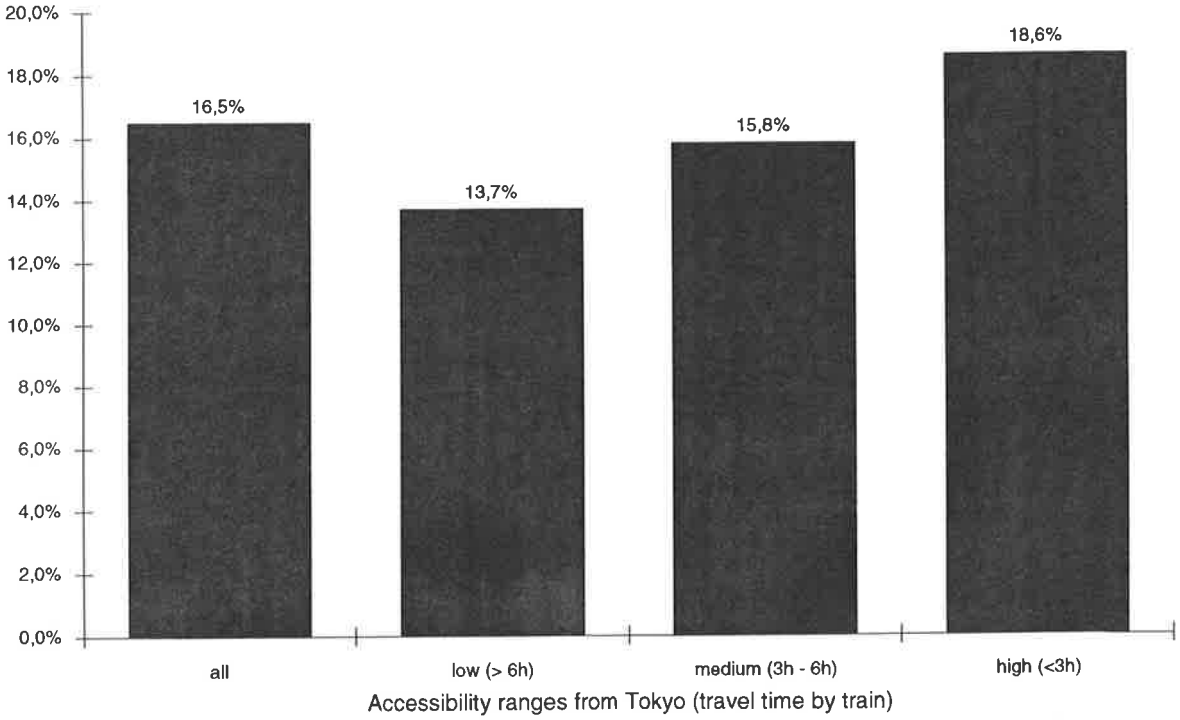

Figure 5: High-tech share (weighted aggreg.) of new plant formation per 3 accessibility ranges from Tokyo 1981-89

When looking at the *employment magnitude of Technopolises* it turns out that with increasing travel time from Tokyo the maximum size of Technopolises (measured in terms of employment at the beginning of the policy) tends to decline, in other words peripheral Technopolises tend to be smaller than more central ones (figure 7). In order to neutralize the size factor of Technopolises we then looked at new plant formation intensity (per 100.000 employees) and it showed that for the entire observation period 1981-89 **the smallest Technopolis size group had by far the greatest intensity of both total and high-tech new plant formation** (figure 8). It furthermore showed that this intensity again increased after Technopolis establishment particularly in the smallest Technopolis size-group (10.000 - 29.999 employees) with high-tech new plant intensity, however, still slightly higher in the middle (40.000 - 49.999 employees) size-group (figure 9). New plant creation intensity therefore appears to have increased after Technopolis establishment particularly in **peripheral locations and in small and medium-sized Technopolises** which prevail there.

We then checked for the influence of *interregional/national infrastructure*, particularly regarding air and rail connections. It turned out that the relatively small differences in *available air-transport facilities* showed no noticeable relation to new plant formation (in part probably because availability of a nearby airport was an ex-ante condition for the establishment of a Technopolis, and differences existed mainly with regard to number of daily/weekly flights).

As regards *rail connections*, Technopolises with direct (high-speed) Shinkansen access not only showed higher new plant formation (both total and high-tech) but also had higher increases after Technopolis establishment than those without (figure 10).

This seems to indicate that **direct Shinkansen access was an important precondition for new plant and new high-tech plant formation and for enhancing the effect of Technopolis establishment** in this respect.

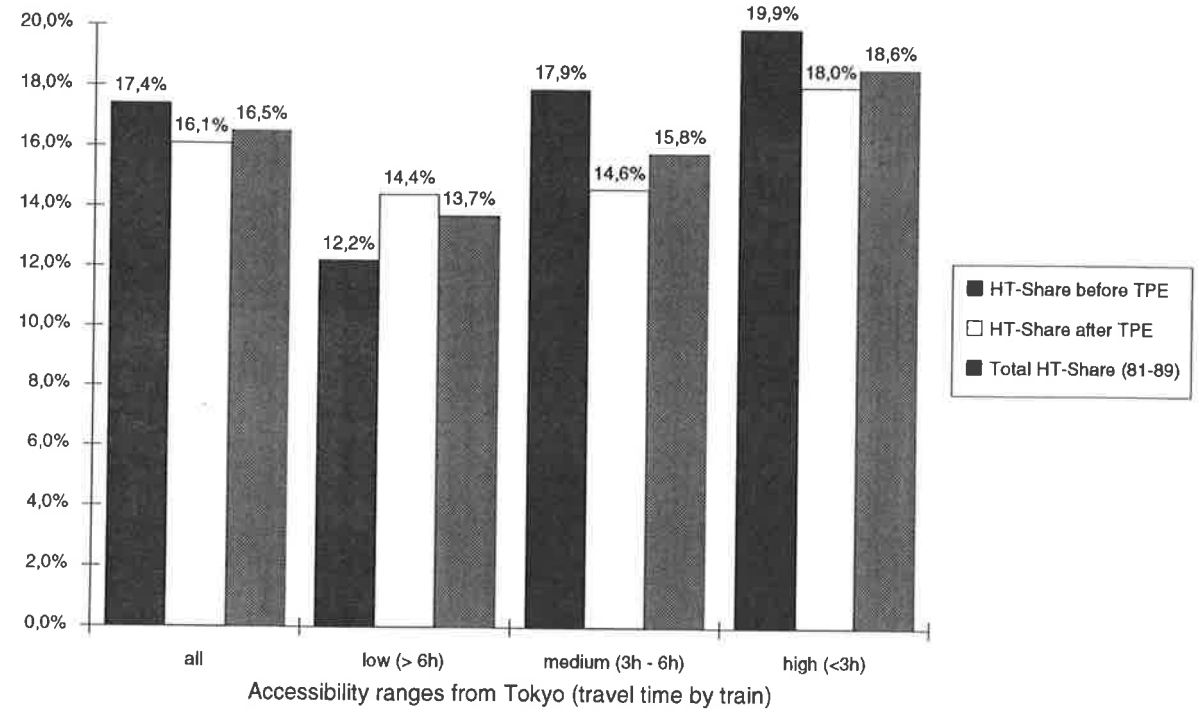

Figure 6: High-tech share (weighted aggreg.) of new plant formation per 3 accessibility ranges from Tokyo, before/after Technopolis establishment (TPE) and 1981-89

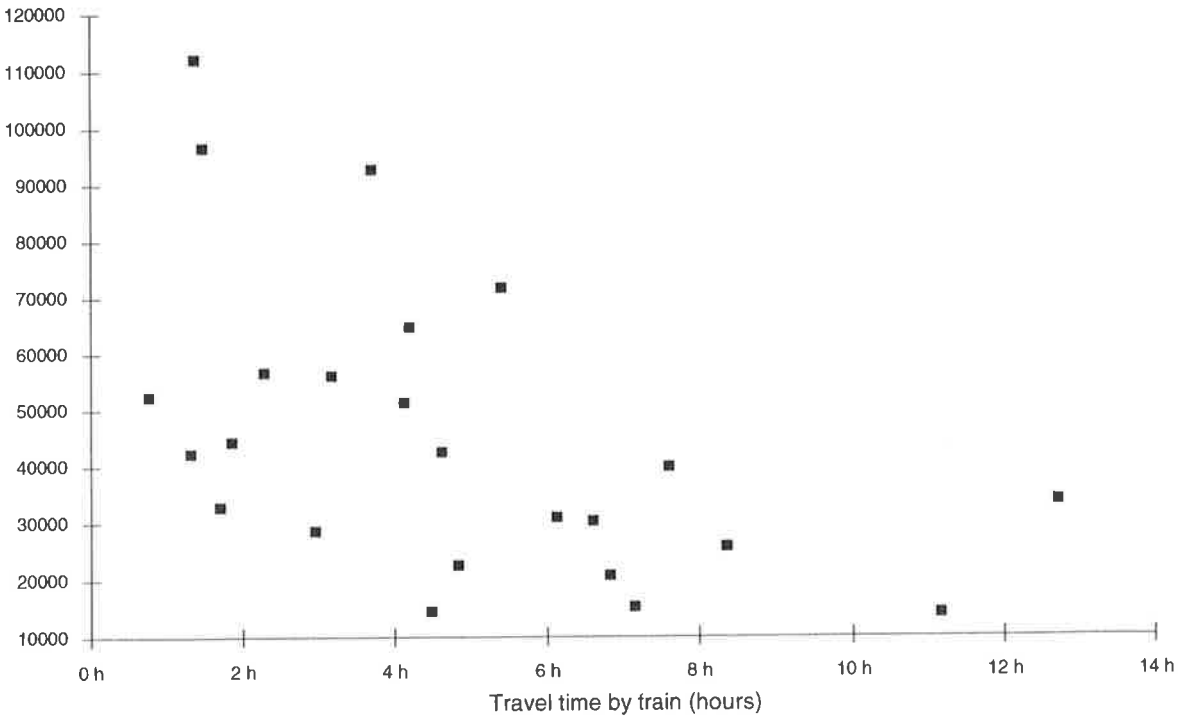

Figure 7: Technopolis size (manuf. employm.) 1984 by accessibility from Tokyo

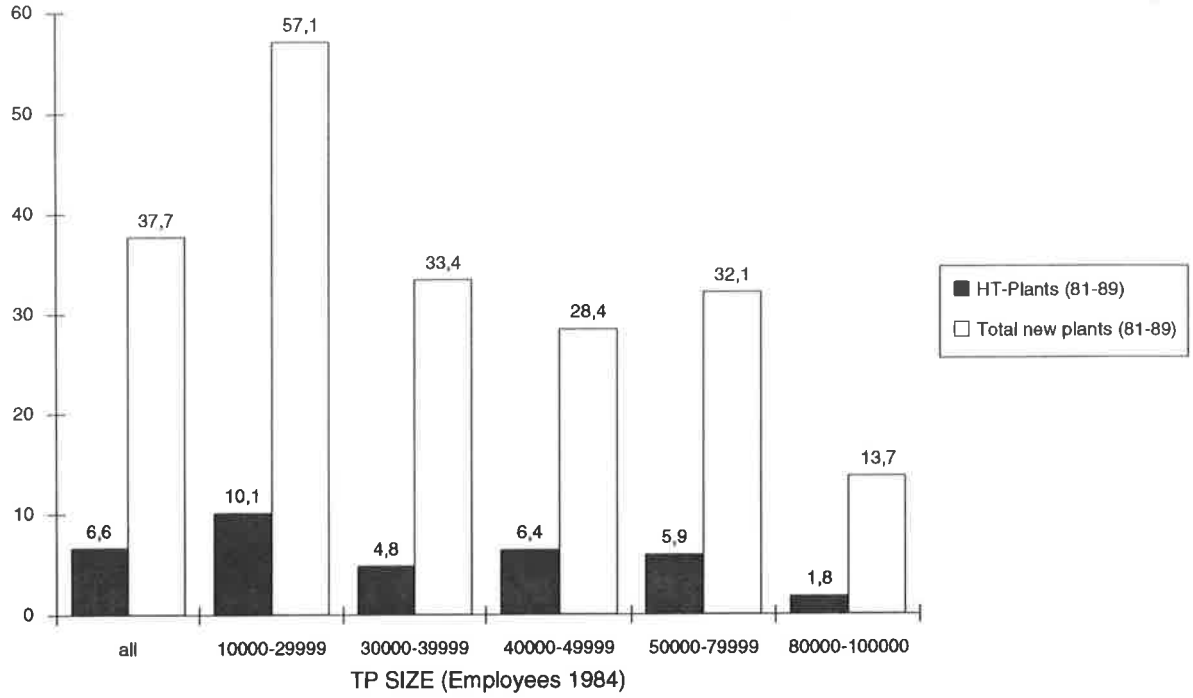

Figure 8: Average annual total/high-tech new plant formation intensity (per 100.000 employees) by TP size group

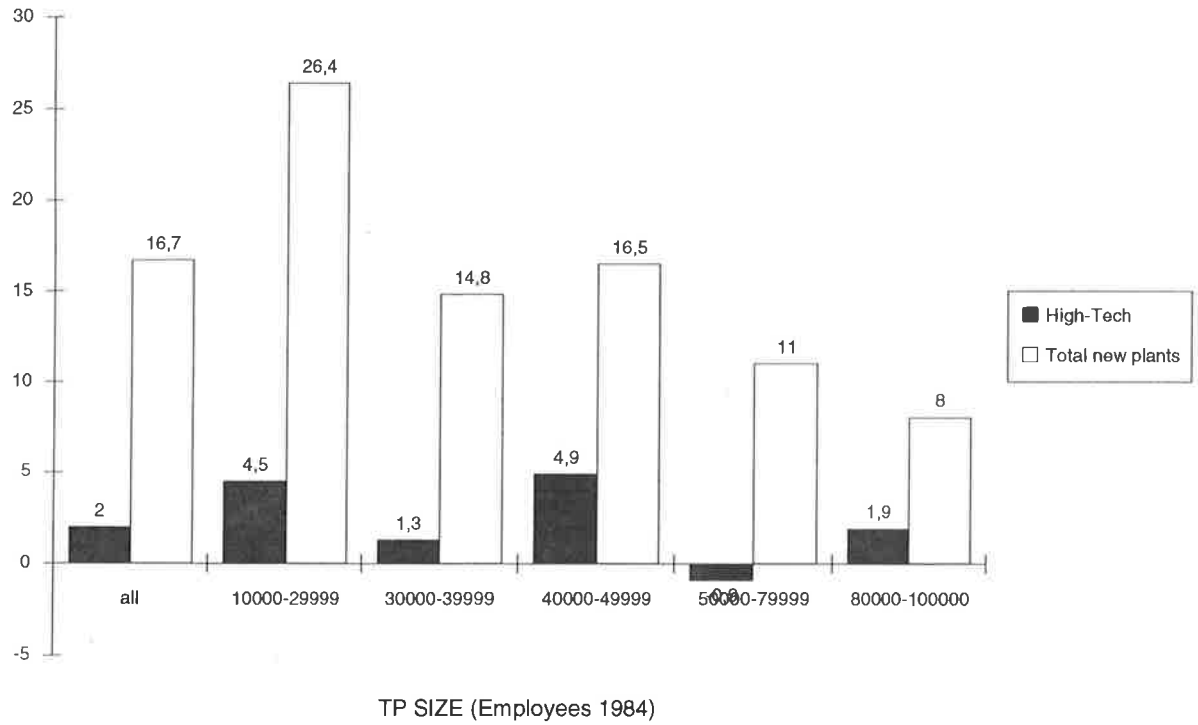

Figure 9: Average change of new plant formation intensity before/after TPE by TP size group

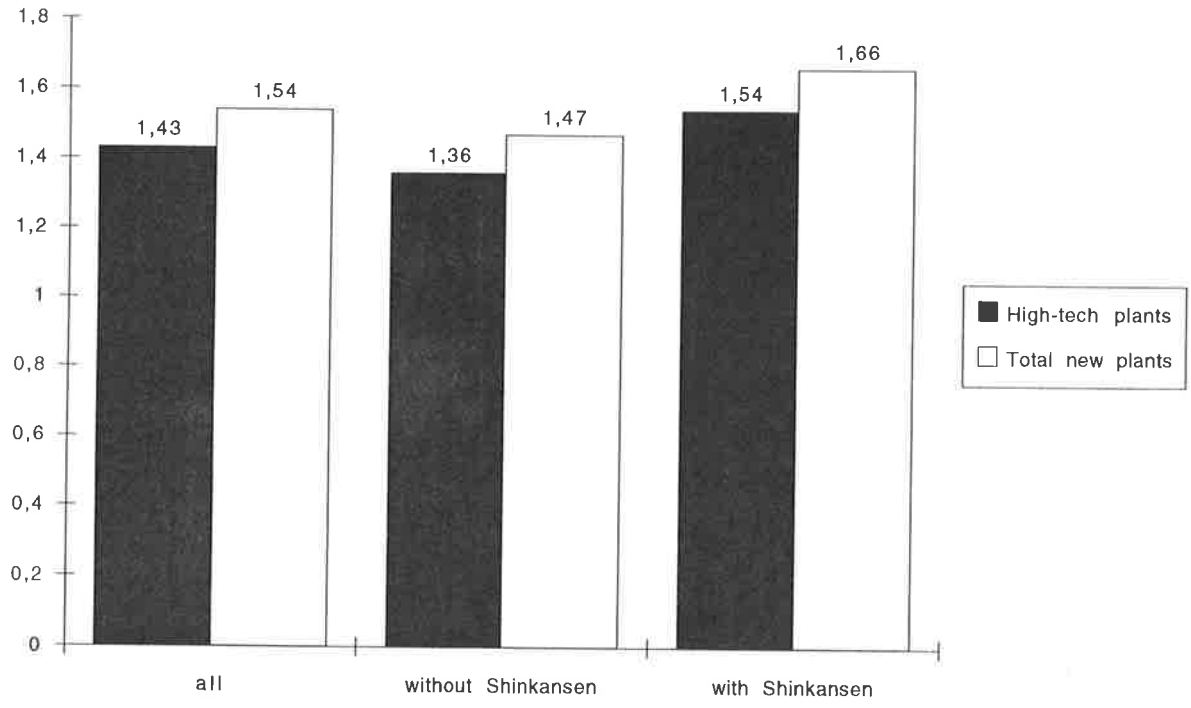

Figure 10: Ratio of average annual new plant formation after/before TPE (weighted aggreg.) by Shinkansen-connection

As regards *local Technopolis infrastructure*, the written survey undertaken by the senior author showed that the common facilities most frequently offered by Technopolises were applied research centres, facilities for basic research, for product development, and common communications facilities (figure 11). Of these, particularly the first three are typically R&D oriented. Technopolises offering 3 out of these 4 types of **common facilities** showed the highest overall new plant formation intensity after Technopolis establishment. New high-tech plant formation intensity was highest in areas offering the first three (typically R&D related) common facilities, but already two of these facilities were enough to permit the largest increase in new high-tech plant formation intensity after Technopolis establishment (figure 12) which in all cases included an applied research centre.

When considering the *stock of high-tech plants*, the survey showed that the 14 Technopolises which replied to this question had a high-tech share of manufacturing plants slightly above the national average and were exceeded only by the metropolitan area of Tokyo, while Osaka and Nagoya metropolitan areas had substantially lower high-tech shares (figure 13).

Looking at the *overall disparities between Technopolis areas in new plant and new high-tech plant formation intensity*, at first in *non-spatial terms*, both have been reduced after Technopolis establishment. The Lorenz curves (figures 14 and 15) show that particularly the initial strong disparity in new high-tech plant formation intensity was reduced considerably (decline of Gini-coefficient from 0.49 to 0.35), while also the initially smaller disparity in total new plant formation intensity declined, though to a lesser extent (Gini-coefficient from 0.34 to 0.26).

If we now look at the *spatial dimension of disparities* in new plant formation in Technopolis areas (figures 16 and 17), for high- tech new plant formation intensity the initial negative disparity with regard to accessibility to Tokyo turned into a slightly positive one after Technopolis establishment, while for total new plant formation intensity the initially already existing slightly positive slant was reinforced. **This shows that for high-tech plant formation the national lag of peripheral Technopolis areas could be made up for and even slightly reversed.**

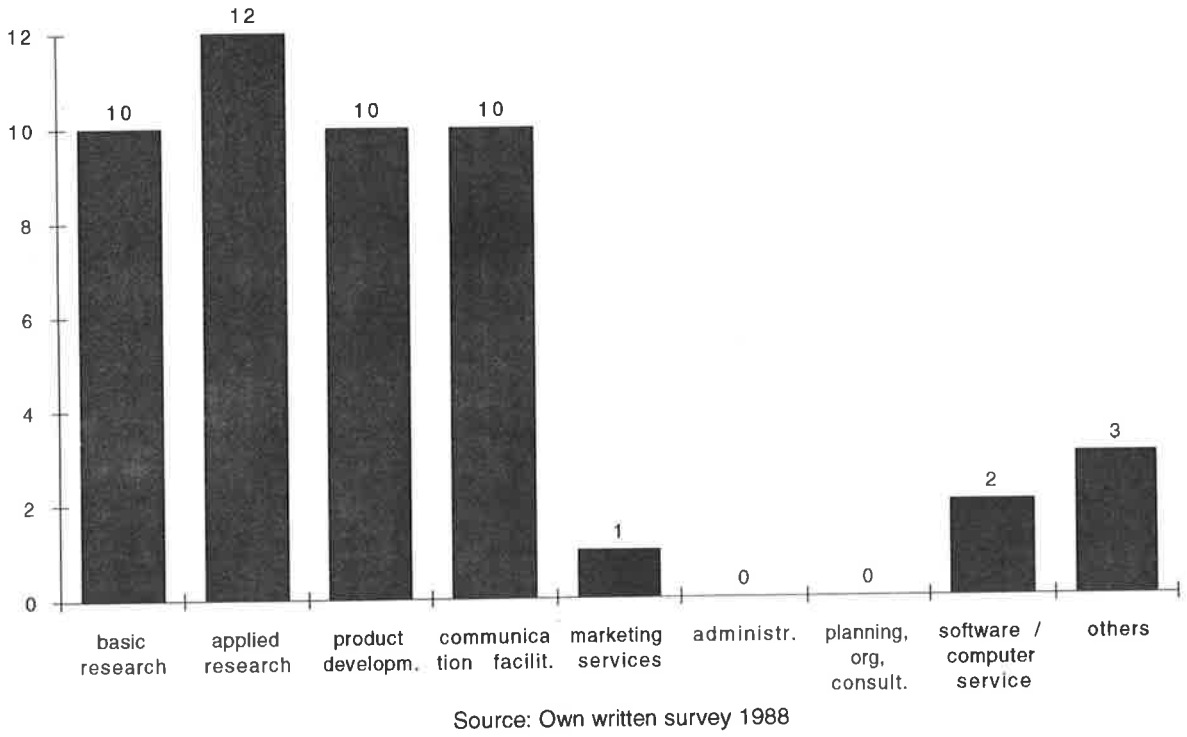

Figure 11: Common facilites offered by 15 Technopolises

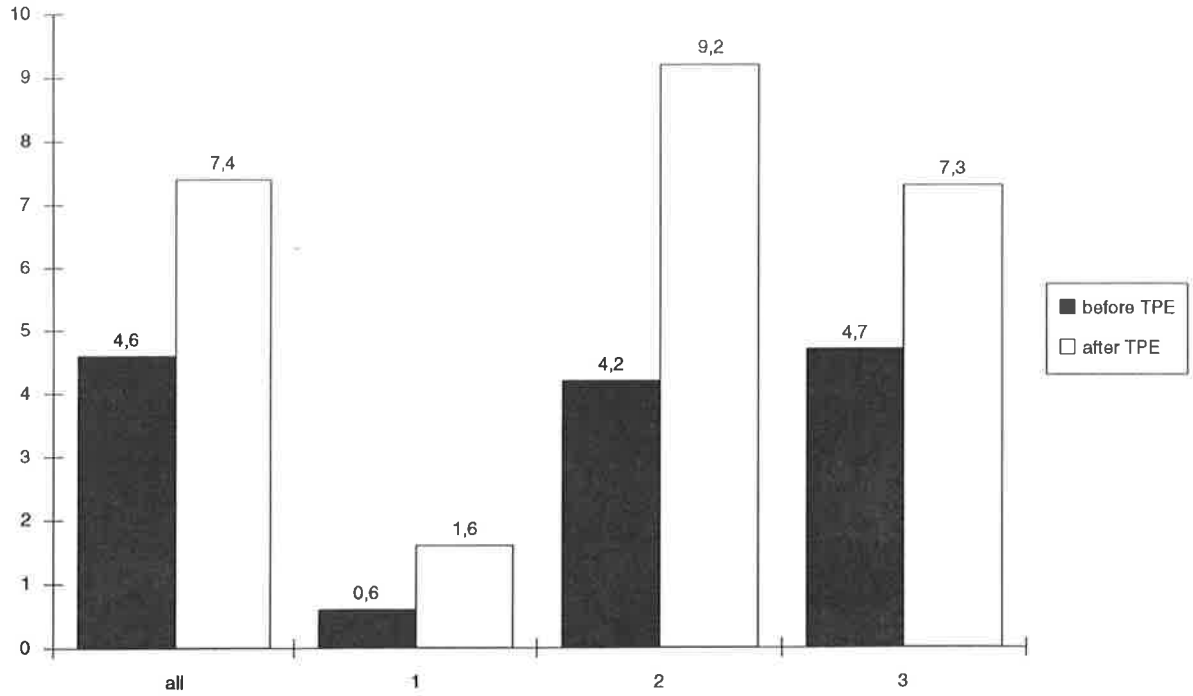

Figure 12: R&D-related facilities related to average new high-tech plant formation intensity (per 100.000 empl.) before/after TPE for 15 TP

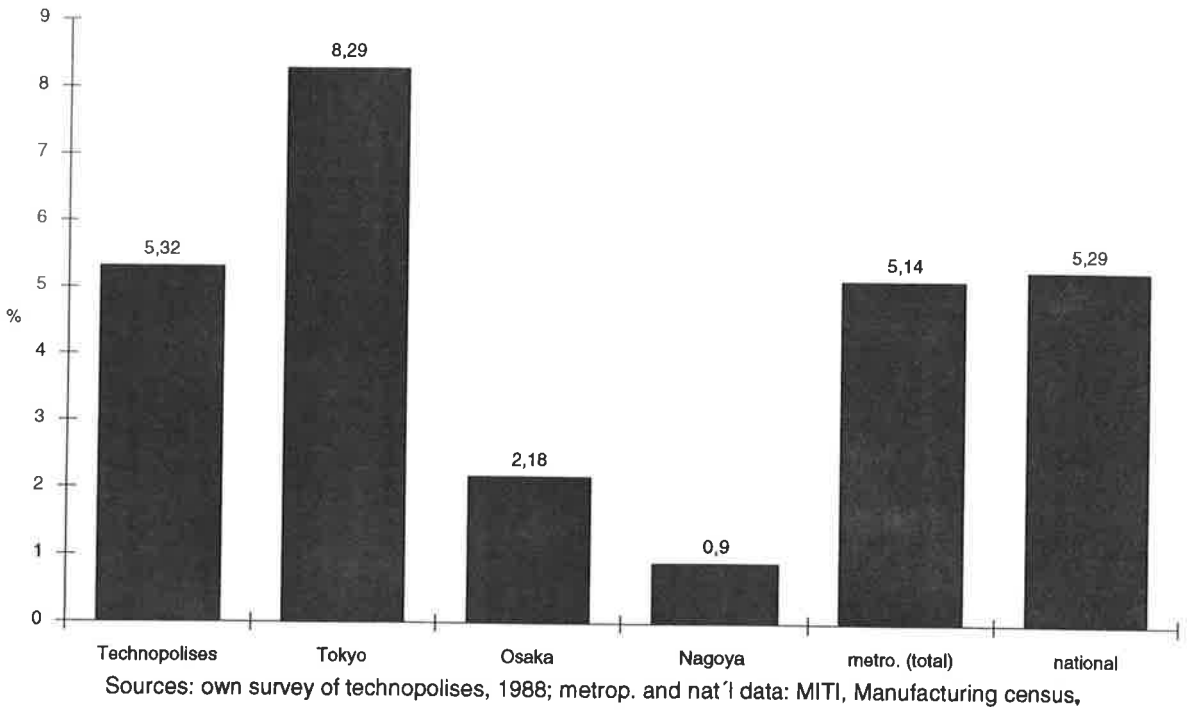

Figure 13: Share of stock of high-tech plants in manufact. plants in 14 TP, in metrop. areas and nat'l average

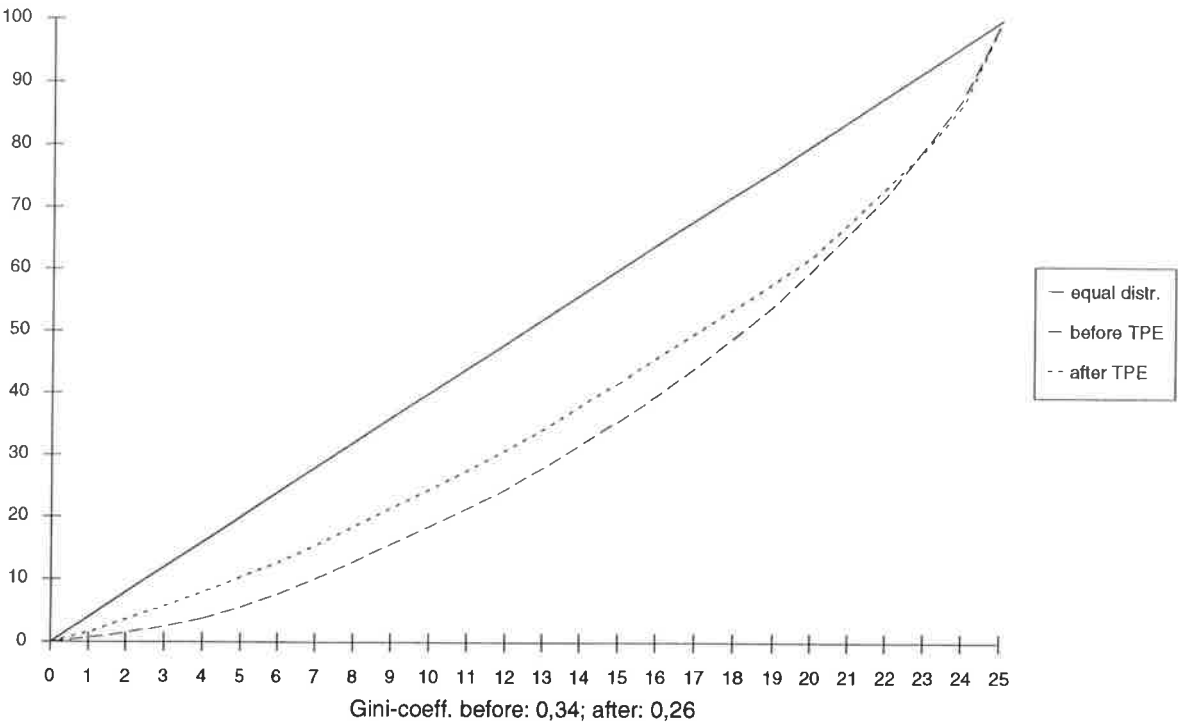

Figure 14: Lorenz curve of total new plant formation intensity before/after TPE

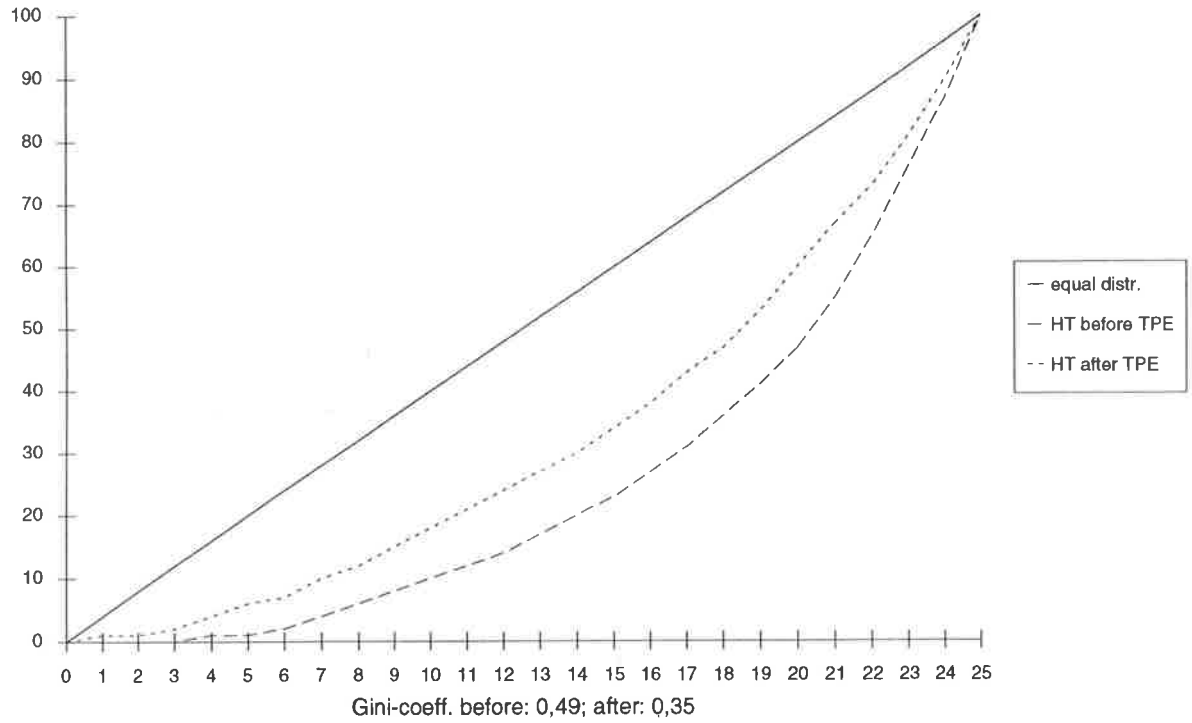

Figure 15: Lorenz curve of new high-tech plant formation intensity before/after TPE

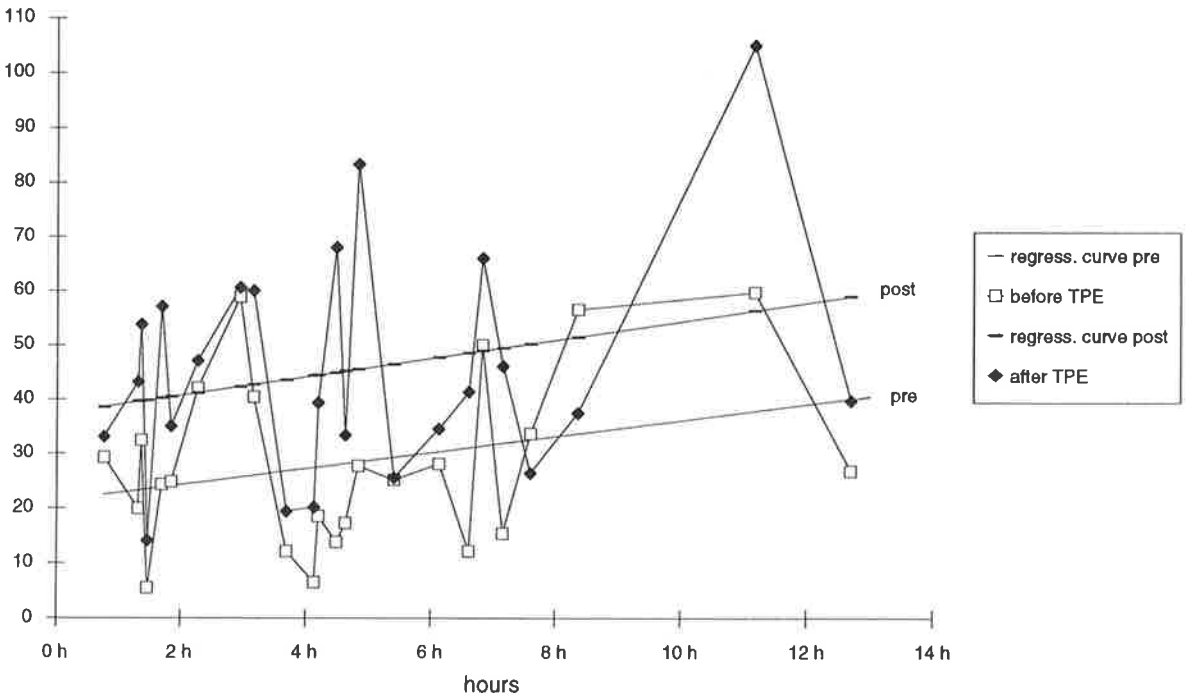

Figure 16: Total new plant formation intensity (per 100.000 empl.) before/after TPE by accessibility from Tokyo (travel time by train)

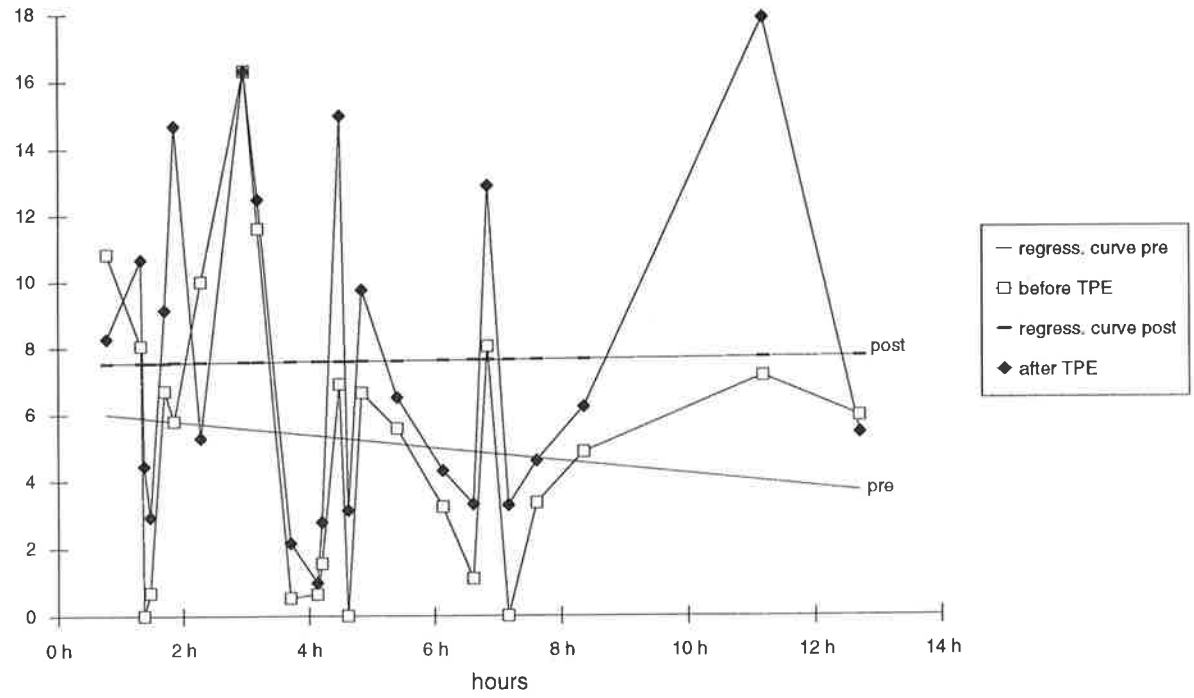

Figure 17: High-tech plant formation intensity (per 100.000 empl.) before/after TPE by accessibility from Tokyo (travel time by train)

In order to evaluate the *broader spatial significance of Technopolises with regard to their surrounding Prefectures* we then made a comparison between the overall development of Prefectures with a Technopolis, those without a Technopolis, and the three Metropolitan areas (Tokyo, Osaka, Nagoya) before and after 1984 when the majority of TP was established.[3]. For a first comprehensive evaluation the rank-sum of changes in the four above-mentioned aggregate variables (shipments, value added, employment, val.add./empl.) was calculated for the observation period up to 1984 and after 1984 (figure 18). It showed that the aggregate rank sum increased most in Prefectures with a Technopolis (+16.1 points), considerably less in non-metropolitan Prefectures without a Technopolis (+4.9) and still slightly less in the three Metropolitan areas (+4.5 points). When then considering each of these four variables seperately, Prefectures with a TP were able to increase their rank most in productivity (v.a./empl.: +7.3 points), followed by value added (+5.3 points) and by shipments (+3.8 points); their rank gains in all three variables exceeded those of non-metropolitan Prefectures without TP (which in productivity even slightly lost ranks) and of Metropolitan areas (which lost ranks in shipments). Prefectures with TP lost ranks slightly only in employment (-0.5 points).

Further analyses of the complex relationships between the development of Technopolises and their surrounding Prefectures as well as the remaining parts of the country are still planned. But from these partial findings it would appear that, at least the dominant 1984 vintage of Technopolises was accompanied by a development of the **respective Prefectures characterized by above average gains in productivity and value added**, very much in line with what one would hope the result of Technopolis policy to be.

[3] In the first group therefore only those 14 Prefectures were included in which a TP was established in 1984

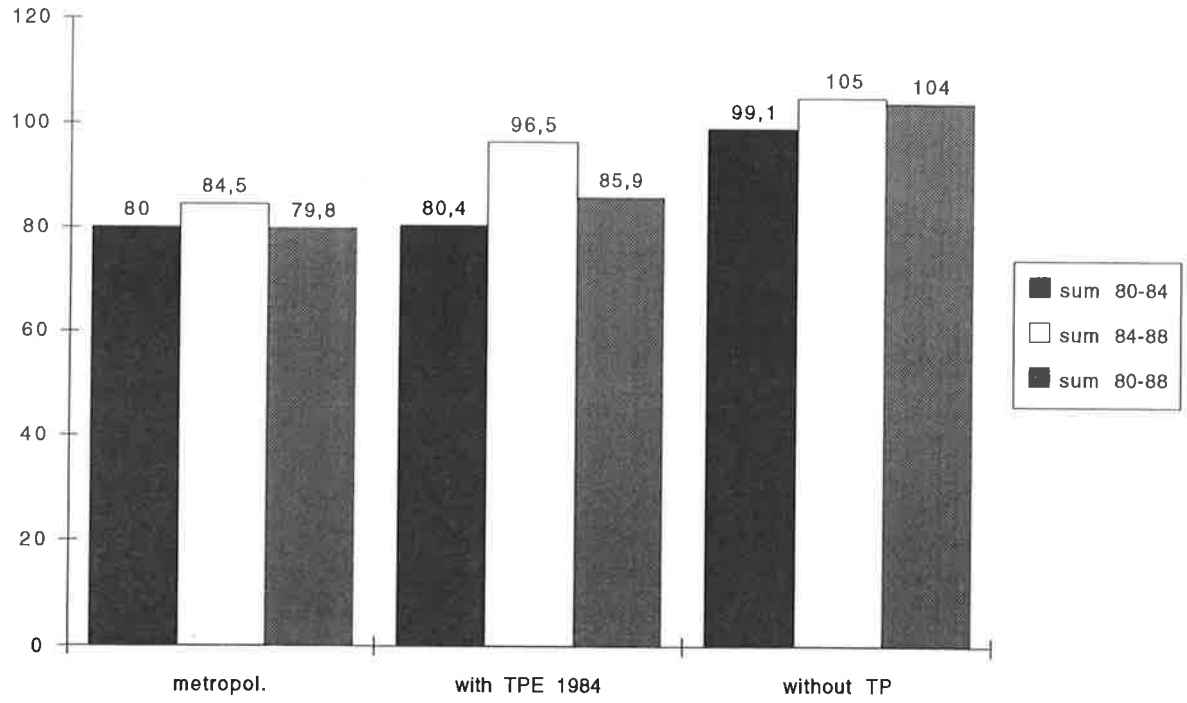

Figure 18: Rank-sum of change rates (Shipments, Value added, Employment, Val. add./empl.) for 14 prefectures with TPE 1984 / without TP and metropolitan areas

5 Conclusions

The establishment of Technopolises coincided with a sustained general industrialization spurt in most of the areas concerned and led to a (less sustained) announcement effect in high-technology new plant formation.

The initially existing substantial lag of peripheral areas in high-technology plant formation intensity was reduced after the establishment of Technopolises, whereby small and medium-sized Technopolises, which prevail in peripheral locations, could particularly increase their new plant formation intensity. This may be due to less scarcity of well trained labour force in smaller and peripheral labour markets.

As far as interregional transport infrastructure is concerned, it showed that direct (high-speed) Shinkansen access was an important precondition for new plant and new high-tech plant formation and for a successful performance of Technopolises in these respects.

Regarding local Technopolis infrastructure, a survey showed that Technopolises offering the following three common facilities: open applied research centres, common facilities for basic research and for product development had the highest intensity of high-tech new plant formation, while already two of these facilities were enough to permit the largest increase in new high-tech plant formation intensity after Technopolis establishment, with the applied research centre always included as a key facility.

In a national perspective, the initial considerable disparity between Technopolises in total new plant and in new high-tech plant formation intensity was reduced considerably after Technopolis establishment. This refers to disparities both overall (Lorenz curve) and in spatial terms, and particularly with regard to the lag of peripheral Technopolises in high-tech plant formation, which could practically be reversed.

As regards the Prefectures surrounding the Technopolises, a first analysis for the dominant vintage of 14 TP established in 1984 showed that the respective prefectures after establishment of

the Technopolises substantially exceeded no-TP-Prefectures as well as Metropolitan Prefectures in rank-sum gains on 4 key variables: those were particulary gains in productivity ranking, to a lesser degree in value added and shipments, while they lost ranks only in employment.

On the whole, the analyses undertaken so far seem to indicate a very positive record of Technopolis development from the point of view of broadening high-tech development also in peripheral Prefectures, of upgrading productivity there, and of reducing and in part inverting the initially existing interregional disparities in technology-based economic development.

References

[1] Kawashima, T. and W. Stöhr, 1988, "Decentralized technology policy: the case of Japan", *Environment and Planning C: Government and Policy*, Vol. 6, pp. 472-429

[2] Kawashima, T. 1985 "Technopolis in Japan: regional development and technological innovation", paper presented at the IIASA Task Force Meeting on "The Role of the Time Factor in Strategic Regional Policy", Tbilisi, USSR, May; copy from the Department of Economics, Gakushuin University, Tokyo, Japan (mimeo)

[3] Stöhr, W. 1986a, "Regional Innovation Complexes", *Papers of the Regional Science Association*, 59, pp 29 - 44'

[4] Stöhr, W. 1986b, "La politique japonaise des technopoles: innovation technologique et institutionelle", in *Technologie Nouvelle et Ruptures Régionales*, EDS. J Federwisch, H Zoller (Economica, Paris) pp 123 - 140

[5] Tatsuno, S. 1986, "The Technopolis Strategy, Japan: High Technology, and the Control of the Twenty-first Century (Prentice-Hall, New York)

[6] MITI, 1982 "Regional Technology Maps of Japan", Ministry of International Trade and Industry, Regional Development Office, Tokyo