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TERRITORIAL INNOVATION COMPLEXES *)

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TERRITORIAL INNOVATION COMPLEXES x)

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1. INTERNATIONAL DIVISION OF LABOUR AND THE TERRITORIAL COMMUNITY

Since about the middle of the 1970's the changing international division of labour, due to a number of causes (Stöhr 1984/a) , has had an increasing impact upon local and regional communities. In broader terms this issue has been analyzed in a recent Symposium co-organized by the present author and UNIDO (UNIDO 1985).

This paper will deal with the more specific question of how regional policy and/or regional action can put local and regional communities into a better position to cope with the impact of changes in the international division of labour. Regional policy, in this context refers mainly to central (State etc.) policy measures "from above" (Stöhr and Taylor 1981), while regional action refers mainly to regional mobilization "from below".

Changes in the international division of labour have recently taken place with accelerated speed and have increasingly put local communities into a state of instability. There have been numerous examples which show, however, that such external instability can also promote spurts of creativity in local communities, particularly if it is combined with the existence of certain local factors such as local competence and synergy (Andersson 1985). This point shall be taken up more concretely further below in sections 6 and 7.

Regional policy, under these changing external circumstan-

ces, has been forced to also become more inventive, and instead of mainly central (State, etc.) supported measures (usually focussing on instruments such as regional capital incentives, infrastructure investment, interregional income transfers and the promotion of interregional factor mobility) has experimented with new measures geared towards the promotion of regional innovation and the integrated mobilization of endogenous regional resources (Stöhr 1984/a). In many cases successful action to improve the international competitiveness of regional communities also started at the regional level, and we shall analyse some relevant test cases in the last section of this paper. There we shall also deal with a new national policy to stimulate regional resource mobilization and innovation, the Japanese Technopolis policy (Stöhr 1985).

2. THE ROLE OF INNOVATIONS IN THE SPATIAL DIVISION OF LABOUR

Most theories dealing with the development of local economies in the spatial division of labour so far have been based on explanations via discrete economic factors, usually the least mobile ones. Traditional location theory based explanations on the availability/relative cost, of raw materials (so-called 'Ricardo goods'), of labour (so-called 'Heckscher-Ohlin goods'), of markets (so-called 'Lösch goods') or of agglomerations (so-called 'von Thünen goods', cf. Giersch 1979). All these explanations were geared towards the requirements of traditional manufacturing industries (today often epitomized by the term "smokestack industries"), major inputs of which were raw-materials,

labour and capital, and which in their productivity relied mainly on scale and agglomeration economies. Technological or information inputs were hardly explicitly introduced. Similarly, the theory of international trade based on the Heckscher-Ohlin paradigm assumed that under conditions of free trade each country (region) "will export and specialize in the goods embodying their relatively more abundant factors" (Tyson & Zysman 1983, p.25). Highly developed countries/regions would therefore be expected to specialize in the export of capital intensive goods, while less developed countries/regions would specialize in the export of labour intensive goods. Leontief (1953) however showed that this is not the case in reality, rather the inverse (Andersson and Johansson 1984): Economies with abundant capital, often export labour intensive goods and services, while economies with abundant labour frequently export capital intensive goods. This "inversion" has been explained by the fact that international trade theory assumes equal access to the same production technology (Tyson and Zysman 1983, p.24), an assumption which in reality does not hold (Stöhr, 1984/b). This would mean that differences in technological inputs seem to be a major determinant in the spatial division of labour.

Andersson (1985) e.g. has shown on the basis of Swedish data that interregional comparative advantage is closely related to the relative magnitude of R+D expenditure by firms in each region. If this is so, then an important question is what determines the spatial distribution of R+D expenditures, or - in further consequence - what determines the spatial distribution of high technology industries and of

entrepreneurial innovation stemming from R+D investment.

3. ON THE DEFINITION OF TECHNOLOGICAL INNOVATION AND HIGH-TECH INDUSTRY

A definition of technology useful for our present purpose is "a formal and systemic entity of knowledge and skills in order to realize and control complex production techniques/processes" (de Smidt 1981). Innovation, furthermore, can be defined as the first commercial utilization of new scientific-technical knowledge within one enterprise (Eckert 1985, p.4). Following this, we can define technological innovation as the (first) commercial utilization of a formal and systemic entity of knowledge and skills within an enterprise to realize and control complex production techniques/processes.

This definition can refer to the introduction of new products (product innovation) and of new production processes (process innovation).

High-technology industries, on the other hand, have been defined as firms with a (1) above average ratio of R+D expenditure to net sales, (2) above average percentage of the labour force engaged in engineering, scientific, professional, and technical work, and (3) rapid growth in terms of employment and output (Swyngedouw and Archer, 1985). These are useful operational variables for firms or industries which are in a good position to apply innovation in their corporate strategies to attain competetive advantage over rivals (Malecki 1983).

As for their spatial distribution, high-tech industries and R+D activities would appear much more mobile and footloose

than the more traditional industries of the above mentioned Ricardo, Lösch, v.Thünen, etc. types. "Traditional location factors are of limited importance (for high-tech industries) -..... these firms are considered footloose with respect to markets, sources of raw materials and transport" (Premus 1982).

4. RECENT LOCATIONAL ANALYSES OF HIGH-TECH INDUSTRIES AND R+D ACTIVITIES: THE MONO-CAUSAL TRAP ?

Locational analysis of the distribution of high-tech industries and R+D activities has - very much like for traditional industries as mentioned above - so far mainly regarded the importance of discrete factors in an mono-causal approach. Discrete factors such as the availability of universities, of public research institutes, of a highly skilled labour force, of urban facilities, an agreeable environment, transport facilities etc.- have been analyzed regarding their spatial correlation with the emergence or sustainability of high-tech industries and entrepreneurial innovation.

These analyses typically were either done with a macro-approach, generally correlating the spatial distribution of individual factors with that of high-tech industries, or with a micro-approach, usually via firm surveys.

The results of these analyses have been rather ambiguous as we shall show by a number of examples. We shall then pose the argument that this ambiguity is mainly due to the iso-

lated analysis and assumption of additivity of universally discrete factors while in reality innovation generally seems to be created by the mutual - and occasionally quite unique - interaction (synergy) of various of these and other factors within rather different local or regional environments.

5. EXAMPLES OF RECENT ANALYSES OF LOCATION FACTORS OF HIGH-TECH INDUSTRY OR R+D ACTIVITIES

The major factors studied in the analyses quoted, by way of example were (see also Fig.1):

- Universities (esp. science/technology departments) and Public Research Institutes

  Many high- technology parks are located close to universities (in the USA: Silicon Valley close to the universities at San Francisco, the Route 128 Technological Complex close to the universities at Boston and Cambridge, North Carolina's Research Triangle Park close to 3 universities; in France the zone of research and new industries in Southern Paris close to the universities of Orsay and the Ecole Polytechnique (Aydalot 1985), in Britain the Science Park of Cambridge close to its university. The main factor for this proximity seems to be the availability of highly qualified manpower and its incubator function for new enterprises (Keeble and Kelly 1985). - Similarly the nearness to research centers has been considered an important location factor for high-tech industries (Thwaites 1982, Levy 1983, Premus 1982).

Fig.1

LOCATION FACTORS OF HIGH-TECHNOLOGY INDUSTRY AND R+D ACTIVITIES

(1) Aydalot 1985, (2) Bouman, Thuis & Verhoef 1985, (3) Brotchie et al. 1985, (4) Ewers & Wettman 1980, (5) Ewers 1984, (6) Hicks 1985, (7) Keeble & Kelly 1985, (8) Levy 1983, (9) Malecki 1984), (10) Molle 1983, (11) Mouven & Nijkamp 1985, (12) Oakey 1981, (13) O'Farell, (14) Stöhr 1985, (15) Thwaites 1982.

Yet, micro-analyses have shown that enterprises in many of these high-tech parks make no more use of research facilities in nearby universities than over long distance (Molle 1983, Aydalot 1985).- "Knowledge Centers" as a combination of universities, research centers and other scientific infrastructure have been analyzed regarding their importance as a location factor for high-tech industries in the Netherlands (Mouwen and Nijkamp 1985) and they found no significant correlation between them; from this the authors derived the conclusion that the establishment of "knowledge centers" would have no significant influence on the location of high-tech industries. At first sight all these results appear contradictory and the role of knowledge creating institutions rather ambivalent in this context.

The following three factors seem to play a less ambiguous role but they are closely interrelated among each other, as we shall show later.

- A highly skilled labour force is uniformly considered a key location factor for high-tech industry (Levy 1983). Hicks (1985) found e.g. in studies on high-tech industries in the Dallas-Fort Worth region, Texas, that "the key location factor influencing the siting of business in the Computer and Data Processing Services industry involve the accessibility of business establishments and actual or potential labour pools to one another" (p.ii).

- An "agreeable" environment (natural/built) and access

to cultural, educational and (other) urban amenities has also generally been found to be an important locational factor. The reason is that with increasing qualification of personnel, particularly otherwise "footloose" firms are obliged to follow the residential preferences of their staff, oriented to a great extent towards these factors (Aydalot 1985). In this way, the residential preferences of technical personnel have been an important location factor for R+D (Oakey 1981, Malecki 1984). Equally, the residential environment appears as a major locational motive for new technology firms (Brotchie et al. 1985; cit.Giaoutzi, 1985).

- A diversified urban base combining administrative, commercial and cultural functions with industrial activities - usually cities pre-dating the industrial revolution - were found by Aydalot (1985) to have a greater innovative capacity in France than cities which emerged only with the industrial revolution and which are usually dominated by only a few sectors and few large enterprise. They usually had few potential entrepreneurs. - A high percentage of small/medium size firms and a large number of entrepreneurs already existing in this context appeared as a favourable climate for the creation of new enterprises. It seems as if enterprises were created by enterprises, or more precisely by children of entrepreneurs (Aydalot 1985). So in France the number of new enterprises correlates highly with the number of already existing enterprises, Aydalot (1985) formulates it this way (my translation): "Each enterprise carries with it a certain capacity of

initiative, expressed by a capacity to decide locally, to control the environment, it constitutes a kind of nursery for new enterprises". (p.3).

- The availability of consulting and information services has been found to be an important factor for entrepreneurial innovation in most analyses (cf. e.g. the comprehensive study made for the FRG by Ewers, Wettmann et al. 1980).
- The availability of venture capital is also usually considered an important factor for technological innovation although opinions diverge as to whether the existence of local loan or venture capital institutions actually is a crucial factor as compared to its national availability (Ewers & Wettmann 1980). More recent studies found little importance of (Bouman, Thuis & Verhoef 1985), or even no correlation (Mouwen and Nijkamp 1985) between the local availability of venture capital and the emergence of high-tech industries.
- Access to airport, rapid surface connection & telecommunication networks are a further factor considered important for the establishment of high-technology industries as e.g. studies for the Japanese Technopolis policy have shown (Stöhr 1985).

The ambiguity of the results referred to above is shown by the fact that only a few of these - logically fully plausible - factors seem to have a higher coincidence with actual innovation.

Particularly, the three factors mentioned in the middle

group appear to be in mutual circular causation and represent residential rather than entrepreneurial location factors: the regional availability of a highly skilled labour force, an agreeable environment, cultural, educational and other urban amenities. This would indicate a close relationship between residential quality and entrepreneurial innovation. In this case jobs actually seem to follow people (at least as regards the preferences of highly qualified personnel). Such interaction between different local factors - which will be dealt with as synergy later on - appears to be an important prerequisite for high-tech industries and entrepreneurial innovation, rather than just their individual presence.

The third group of factors mentioned (diversified urban base with many enterprises existing, good access to rapid transport and communication networks) would seem to indicate that it were mainly the older urban centers and the main transport and communication axes which fostered innovation.

As we shall show in the last part of this paper, areas outside of these regions have however also been able to innovate, and it seems that an important condition for this has been precisely the interaction (synergy) of important local factors - rather than just the pure existence of (possibly isolated) single factors, as the analyses quoted above implicitly assumed.

The remaining factors analyzed in recent studies showed even more ambiguous results, although these factors normally seem most closely related to entrepreneurial innovations and

often have been considered as key instruments for their promotion: the location of (especially science and technology oriented) universities, research institutions and "knowledge centers", the regional availability of consulting and information services, as well as of venture capital banks. These factors in most of the studies quoted individually appeared to have a rather weak relation to the spatial distribution of high-tech industries and to entrepreneurial innovation. Mouwen & Nijkamp (1985) conclude from a related study on the Netherlands, for instance, that a policy of strengthening knowledge centers is not likely to have a substantial impact on the regional innovation potential (p.21).

Two explanations may be relevent for the ambiguity of these results: one - which has been mainly given in these studies - that the services analysed are not sensitive to distance and can therefore also be utilized over regional or even national borders (which is in fact done particularly by transnational firms). Second, that not by the pure existence of these factors but only by their close functional interaction among each other will innovation emerge. In the latter case the explanation for the lack of entrepreneurial innovation in the vicinity of such services is not that their location or distance is irrelevant, but rather that their innovative effect is hampered by a lack of local/regional interaction.

A very simple and frequently found negative example are the many universities which (at least in European countries)

have very little local innovative effects. Reasons are diverse: their staff may have what has been called an "ivory tower" attitude towards their environment, and/or their contacts may be mainly along disciplinary lines in an international context, and/or the local community may not be able to use their products. Relevant contrasting situations may frequently be found in neighbouring universities such as in Northern Italy (an area about which another more detailled case study will be given in the last section of this paper) is the old town of Pavia whose university is described as "representative superstructure without direct influence on (local) enterpreneurship which in view of its traditional small firm structure has no demand for academics" (NZZ, 1985), quite distinct e.g. from universities in close-by Milano.

6. REGIONAL SYNERGY AS A MORE POWERFUL EXPLANATION OF INNOVATION ?

In explaning growth within local/regional economies, an important step was taken from industrial location theory (basically concerned with the relevance of individual factors for specific sectors) to growth pole theory (Perroux 1955) and its spatial extension growth centre theory (Boudeville 1966) which explicitly introduced inter-industry relations into the explanation of local growth. Not only the sectoral composition of a local economy was considered important but the functional interrelations between sectors, particularly between "leading" and other sectors.

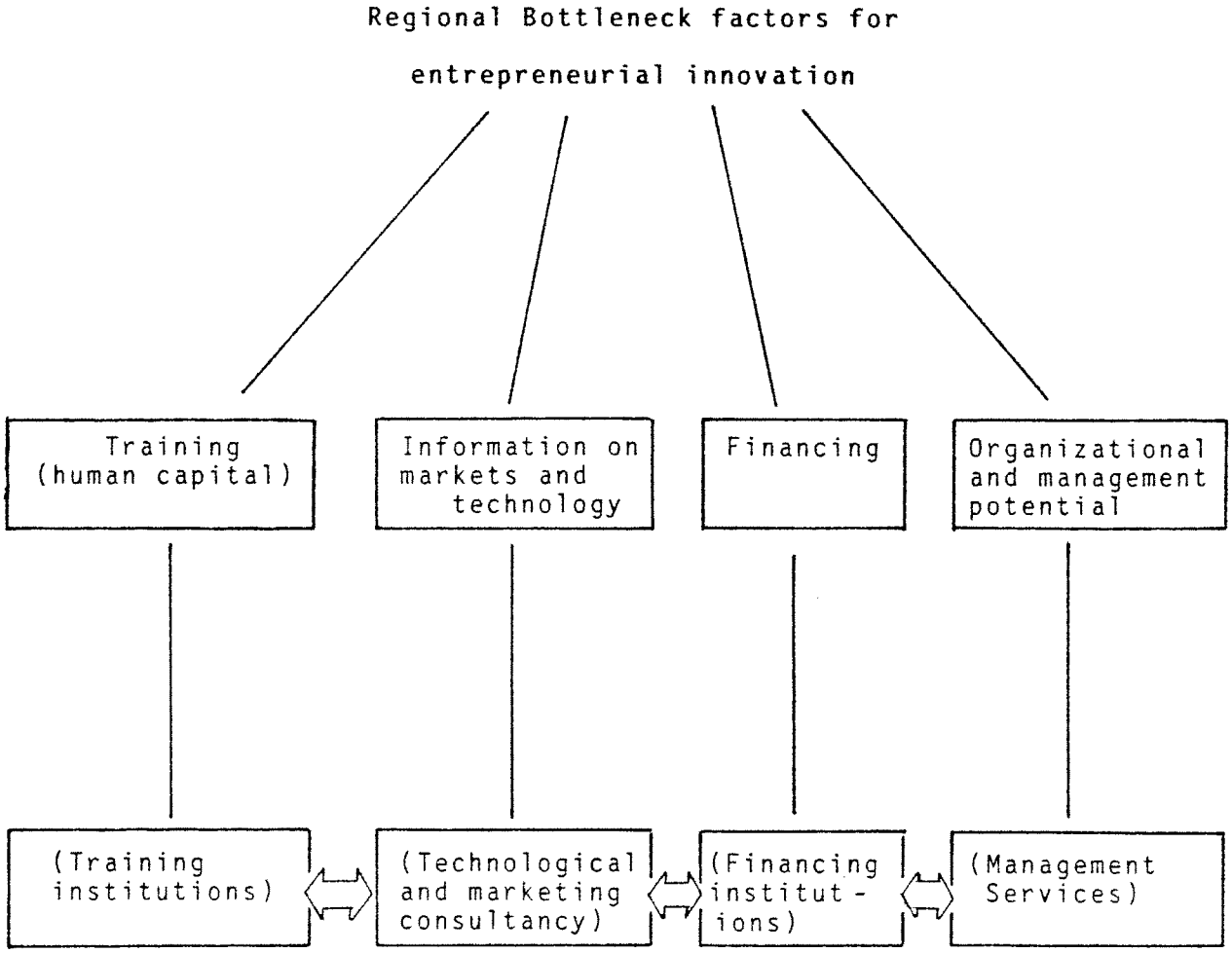
In explaining local/regional innovation, similarly, the unrelated setting side-by-side of single determinants of

innovation obscures rather than clarifies spatial causality as Ewers & Wettmann (1980, p.26) state and they therefore demand a network approach. In their empirical analyses they identified four main bottleneck areas impeding/promoting innovations (p.97): human capital, financing, information on markets and technology, and organizational and management potential (cf. Fig.2). We now contend that not only the availability of all these factors, but their regional interaction is essential for sustained regional innovation.

For the innovative capacity of regions as decisive, Ewers & Wettmann (1980) consider less the pure production operations but rather activities linked to them such as information gathering and processing, planning and decision-making, technical development, marketing, product design, financing etc. (p.26).

In the recently emerging spatial functional specialization - reinforced considerably by multi-locational firms - these functions have increasingly become locationally seperated from each other and from pure production operations. For the FRG e.g. Bade (1985) has shown that while in peripheral areas the percentage of unskilled production workers is more than 1/3 higher than their national average, in the agglomeration cores the percentage of university graduates working in R+D is almost 70 % higher, that of technical and administrative services about 30 % higher than their respective national averages. According to Bade's analysis there exists an almost constant gradient from agglomerations to peripheries in this functional specialization. This gradient

Fig. 2:



Ewers & Wettmann, 1980

has furthermore had an increasing tendency between 1976 and 1983, particularly with regard to pure production functions (increasing bias towards peripheral areas) and with regard to R+D and consulting, EDP and marketing services (increasing bias towards agglomeration cores), whereas other technical and administrative services had their highest increase in the rings of agglomerations (Bade 1985, Table A.1).

Research by Gibbs and Thwaites (1985) shows for Britain that new products developed in research units or plants in core areas usually were not transferred to outlying regions and that "most innovations are put into production at the location where they were originally developed" (p. 15).

This increasing functional specialization of regions (cutting across and going beyond the traditional sectoral specialization) has deprived many regions, particularly the peripheral ones and the old industrial areas, of most of their key functions for innovation.

Andersson (1985) in his paper on "Creativity and Regional Development" considers three prerequisites for creativity: competence, structural instability and synergism. The first two need little further explanation. The last one, synergism, is of special interest in this context, as it refers to the interaction of different (regional) factors. The concept of synergism is taken from chemistry and pharmaceutics where it denotes that the "effect obtained from the combined action of two distinct chemical substances is greater than that obtained from their independent action added together (Encyclopaedia Britannica, Micropaedia, 15th Ed., Vol. IX, p.740).

In regional development this concept would denote that not only the presence of specific agents/institutions within a region but their mutual interaction is a prerequisite for optimizing regional creativity and innovation under conditions of structural instability. Friedmann (1972) has already earlier related the likelihood of local innovation to the intensity of interaction and information exchange. I have in another context called this "integrated regional development" (Stöhr 1981/a). Andersson (1985) chooses Vienna in the period 1890 to 1930 as an example for the importance of competence, synergism and structural instability for a process of creativity (pp. 20 ff.).
In a historical perspective, Colombo and Lanzavecchia (1985) showed that the location of advances in industrial technology has in the past depended not so much on where inventions were made but rather where a "scientific apparatus" existed, i.e. where adequate relationships between science, industry, information, education and the State existed (p.3).

As a negative example in this connexion they analyze the lack of industrial innovation in England during the latter part of the 19th century where such an apparatus was missing. A contemporary positive example no doubt has been Japan in recent decades, where these interrelations were particularly close (cf. also section 7. below).

7. THREE EXAMPLES OF TERRITORIAL INNOVATION COMPLEXES IN PERIPHERAL AREAS

In this section we shall briefly analyze three examples of regions which in recent decades have shown relatively high rates of technological and institutional innovation. We have by intention chosen non-metropolitan areas, within their national context even peripheral areas, to disavow the frequent assertion that innovation can only emerge in major metropolitan centres. In all these cases local and regional initiatives triggered this innovation in what I have elsewhere (Stöhr and Taylor 1981) called "development from below". All of these initiatives have had a major regional impact and only in the last case (the Japanese Technopolis policy) has this local initiative been complemented by systematic promotion also on the part of the national government.

The three examples chosen furthermore have different types of social systems: the first one has a cooperative structure, the second one is essentially based on private enterprise (mainly small/medium sized firms), while the last one is of a mixed "third sector" type (combining local government, local university and private enterprise). This was done to show that territorial innovation does not depend on any one specific social system.

We shall be mainly analyzing the regional synergetic structures underlying these innovation processes. In the following Figs. 3-5 I have therefore attempted to show important patters of interaction within each regional system and the

important interactions with outside. Emphasis is thereby placed on functional and institutional interaction rather than on the usually depicted (physically or financially defined) input-output flows of commodities and production factors.

Analyses with similar objectives have recently been made also for rural areas in developing countries where these synergetic structures have been called "endogenous local receiving mechanisms" (O'uchi and Uphoff, 1985).

Territorial Innovation Complex I: a Cooperative Model

Chosen was the Mondragon Cooperative Group in the Basque Country, Spain, which has been widely analyzed and documented (Thomas & Logan 1982, Stöhr 1984/a) and personally visited by this author.

The Mondragon Cooperative Group comprises about 160 cooperative enterprises geographically dispersed and in a wide variety of manufacturing sectors (ranging from metal working and capital goods, to intermediate products and durable consumer goods), industrial services, training and education, housing, agricultural processing, community services and a consumer cooperative. It is spatially decentralized in a great number of medium and small sized towns and villages South of the major old industrial centres of the Basque Country which focus upon Bilbao and have traditionally been dominated by heavy steel industry and shipbuilding.

While this traditional Basque industry has been in severe crisis for several decades now, and particularly for the past few years has been loosing jobs and closing down plants, the Mondragon Cooperative Federation (the beginning

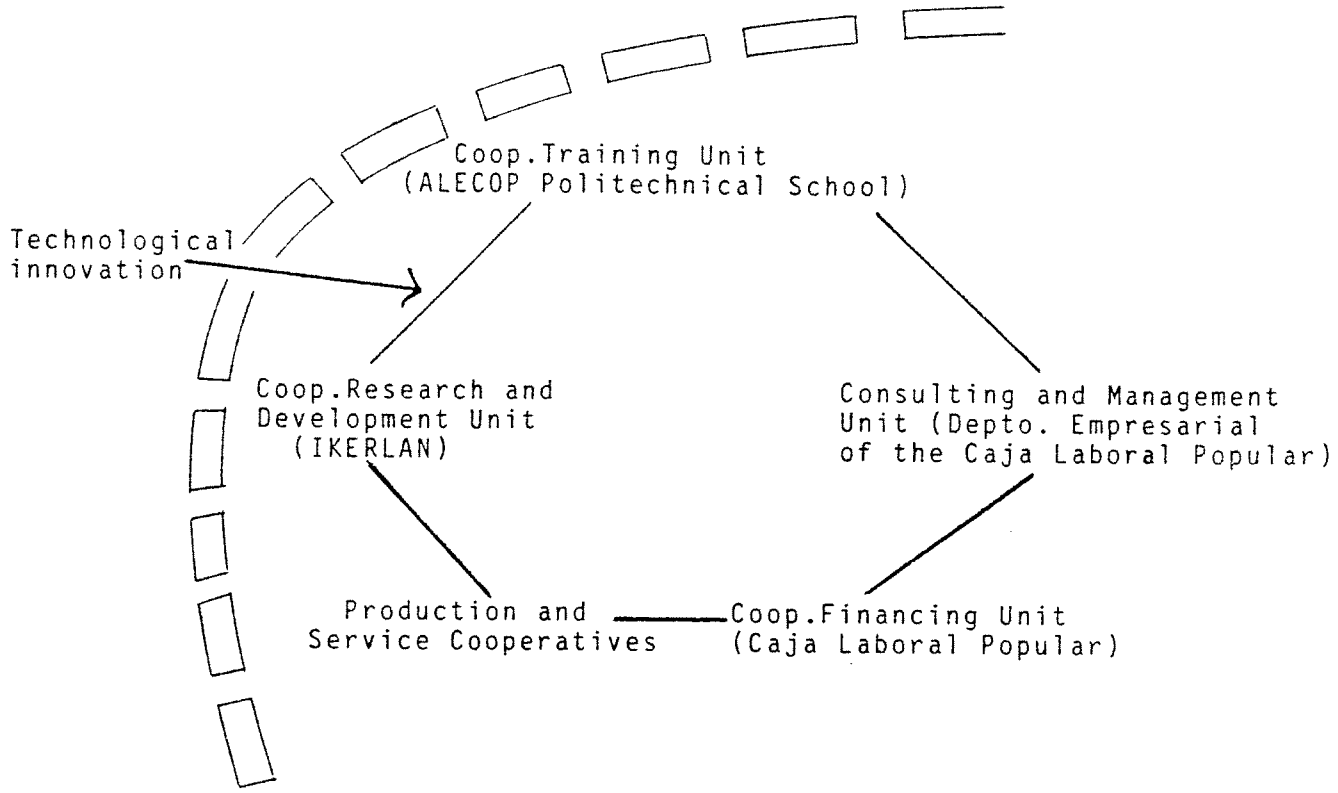
of which goes back to the 1940's), has even during the past few years of most severe international structural adjustment been able to increase the number of its plants and stabilize, in part even increase, the number of workers. This has to a considerable extent taken place with sophisticated technology including process electronics, computer aided design and robot development. But advanced technology has also been developed in more traditional sectors such as household electrics in which the Mondragon Cooperative plants are amongst the technologically most advanced and most efficient ones within the respective national sector, and considerably oriented to export markets.

The relatively high innovation capacity of the majority of the Mondragon Cooperatives is to a considerable extent due to the fact that the Cooperative Federation includes its own training, research and technological development units, consulting services as well as its own financing institution (Caja Laboral Popular). It is therefore organized basically like a large (private) multi-locational company - but with territorial identification and responsibility, not "footloose" like most other multi-locational firms. This endogenous training-research-innovation-financing-production complex (Thomas and Logan 1982) with its intensive feedback mechanisms appears to be mainly responsible for the high innovation rate and the competetiveness of most of the Mondragon plants (Stöhr 1984/a). This is depicted in the upper part of Fig. 3.

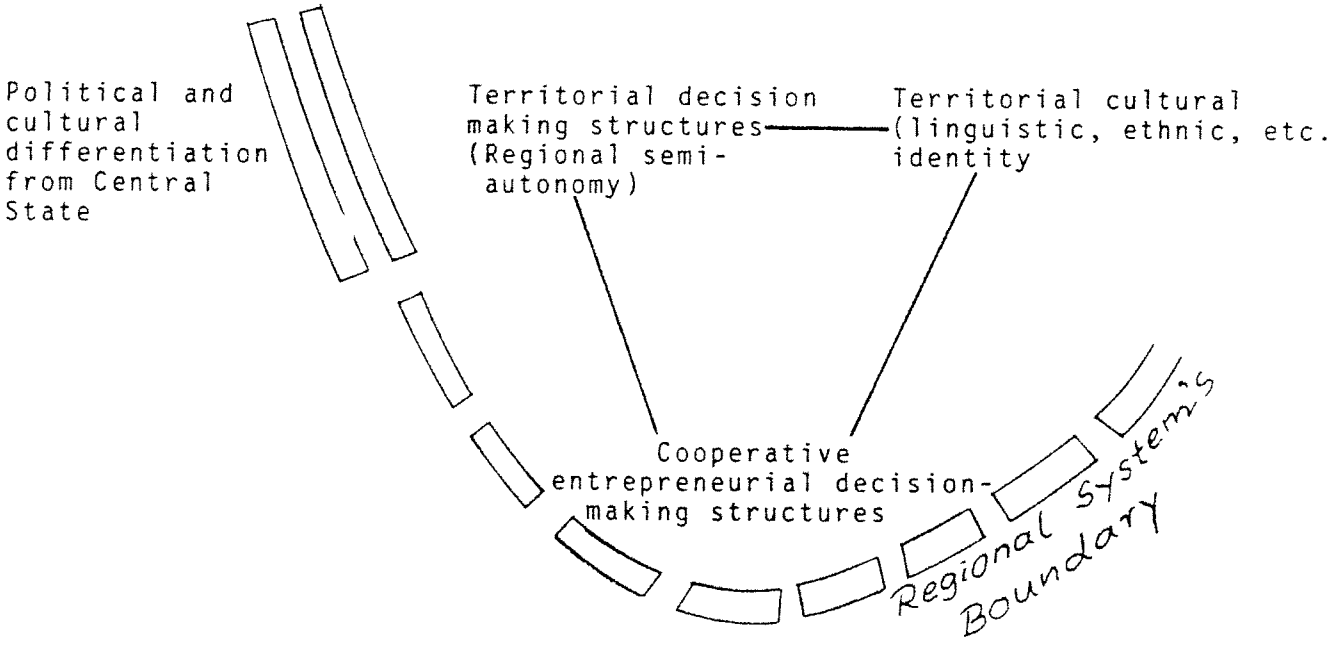
Fig. 3:

TERRITORIAL INNOVATION COMPLEX I: A COOPERATIVE MODEL
THE MONDRAGON COOPERATIVE GROUP, BASQUE COUNTRY, SPAIN

a) territorial technological innovation complex



b) Territorial societal and organizational innovation complex



For the acquisition and development of new technologies from outside an interesting mechanism has been devised: as universities in the Basque Country have so far been insufficiently oriented towards technological innovation, the Mondragon Cooperative Federation sent personell for medium-term stays "in residence" to various outstanding foreign universities and research centers in order to establish contacts and collect relevant information. This stock of information was successively used for joint R+D projects and for own technical development within IKERLAN, the Group's R+D core group, and within individual firms in cooperation with the former. This is an interesting example of how specific key functions for innovation, which are still missing within the region, can be successfully internalized from outside. An important condition for this however appears to be the existence of an innovation oriented regional (synergetic) interaction system combining important other key elements.

A second group of reasons for the relatively high organizational and institutional innovative capacity (including organization of work, etc.) are the participatory structures within individual cooperatives, and between them in the frame of the Cooperative Federation, related to its territorial, cultural and ethnic identification with the Basque Country. Both these are reinforced by an increasing degree of autonomy granted to the Provinces and the Basque Region by the Spanish Central Government. (cf. lower part of Fig. 3.).

The Mondragon Cooperative Federation, inspite of its relatively small quantitative magnitude (about 19.000 members representing only some 2 percent, of the active population

of the Basque Country), in qualitative terms has been playing an important role in the Basque Country. Upon Franco's death in 1975, the Cooperative members, due to their previous organizational structure, participated in key roles in the emergence of local planning committees even before the formal establishment of democratic institutions at local and regional levels in Spain. And after their establishment, the Mondragon Cooperative Federation has been supplying personell for key positions in local, provincial and regional government of the Basque Country.

The Mondragon Cooperative Group therefore, inspite of its relatively small magnitude, constitutes an important factor not only in technological but also in institutional innovation for the Basque Country.

While the Cooperative Group essentially operates in an open market environment with free commodity and factor flows, its major external inputs are technological innovation. A certain "closing off" is only effective in decision-making structures (cooperative decision-making process, regional political and economic autonomy from Central Government) and in terms of capital flows. The latter fact in concrete terms e.g. implies that the financing institution of the Mondragon Cooperative Federation (Caja Laboral Popular) is able to invest the substantial surplus it makes only within the Basque Country (interestingly enough including the Basque areas in France). As Caja Laboral Popular is therby not able to shop around for the most profitable investment on a world-wide scale (as banks normally would), it is forced to generate profitable projects within the Basque Country and promote institutional structures which will facilitate this,

like the ones described above (Stöhr 1984/a).

This territorial "locking in" of capital and surplus, embedded in a competetive international market situation, has therefore created - together with the internal synergetic structures described - what might be considered a self-propelling territorial innovation and adjustment mechanism.

Territorial Innovation Complex II: a private sector model

As a second case study we are using a number of groups of regionally interacting, originally small/mediumm sized private firms in what is called "Third Italy", and which have achieved high innovation rates. They have been described in detail by Piore and Sabel (1983).

The term "Third Italy" is used to distinguish it from the older industrial triangle Milan-Turin-Genoa and from the less developed South. It is "the centre of the new wave of Italian growth... a vast network of very small enterprises spread through villages and small cities of central and Northeast Italy, in and around Bologna, Florence, Ancona, and Venice" (Piore and Sabel, 1983, p.392).

These firms are described by the authors mentioned to be generally small and medium-size (frequently ten workers or less) and to range across a wide spectrum of sectors "from shoes, ceramics, textiles, and garments on one side to motorcycles, agricultural equipment, automotive parts, and machine tools on the other". A significant number of these firms "belong to the most sophisticated and technologically advanced sectors of the industries in which they operate "... and "They work with machinery adapted to their unusual

size and structure (some of them controlled by sophisticated micro-processors), and they yield some of the highest earnings in Italy today". (pp.393, 397).

There are some specific long-established features of Italian society such as the extended family and the tradition of the family enterprise as an endogenous source of labour, entrepreneurship and capital, but Piore and Sabel (1983) feel that these are not an irreplaceable foundation for this development and have often been overestimated in their importance for its success (p. 406 f.). Yet they facilitate a predominantly endogenous supply of labour and capital and thereby reduce external dependence on these factors (cf. Fig.4).

An important precondition for the highly innovative performance of this large number of decentralized small firms appears to be the intensive functional interaction taking place within and between firms in what appears as a highly innovative feedback mechanism: Within firms by close cooperation between owners, designers, technicians and production workers in which "hierarchical distinctions tend to be treated as formalities" (p.400). - Between firms by intensive exchange of ideas between owners, skilled workers and small consulting firms, as well as by direct collaboration between dynamic small firms which share the cost of innovations, exchange orders mutually, have joint marketing, accounting, technical services, common purchase of raw materials, common subscription of loans, etc. (cf. Fig.4). According to Piore and Sabel (1983, p.401) collaboration is

triggered by an interesting mechanism: as firms are all small but growing, once a firm begins to expand and move beyond its original speciality, it finds itself dependent on the help of neighbours with complementary kinds of specialities, and because the neighbours can never anticipate exactly when the positions will be reversed, the help is forthcoming. .. Where invention creates demand and invention is also collective, collaboration is a natural result." Piore and Sabel in fact maintain that while atomistic competition tends to favour cost-cutting and labour exploitation strategies for survival, collaboration frequently offers conditions which favour entrepreneurial product innovation strategies (p. 420).

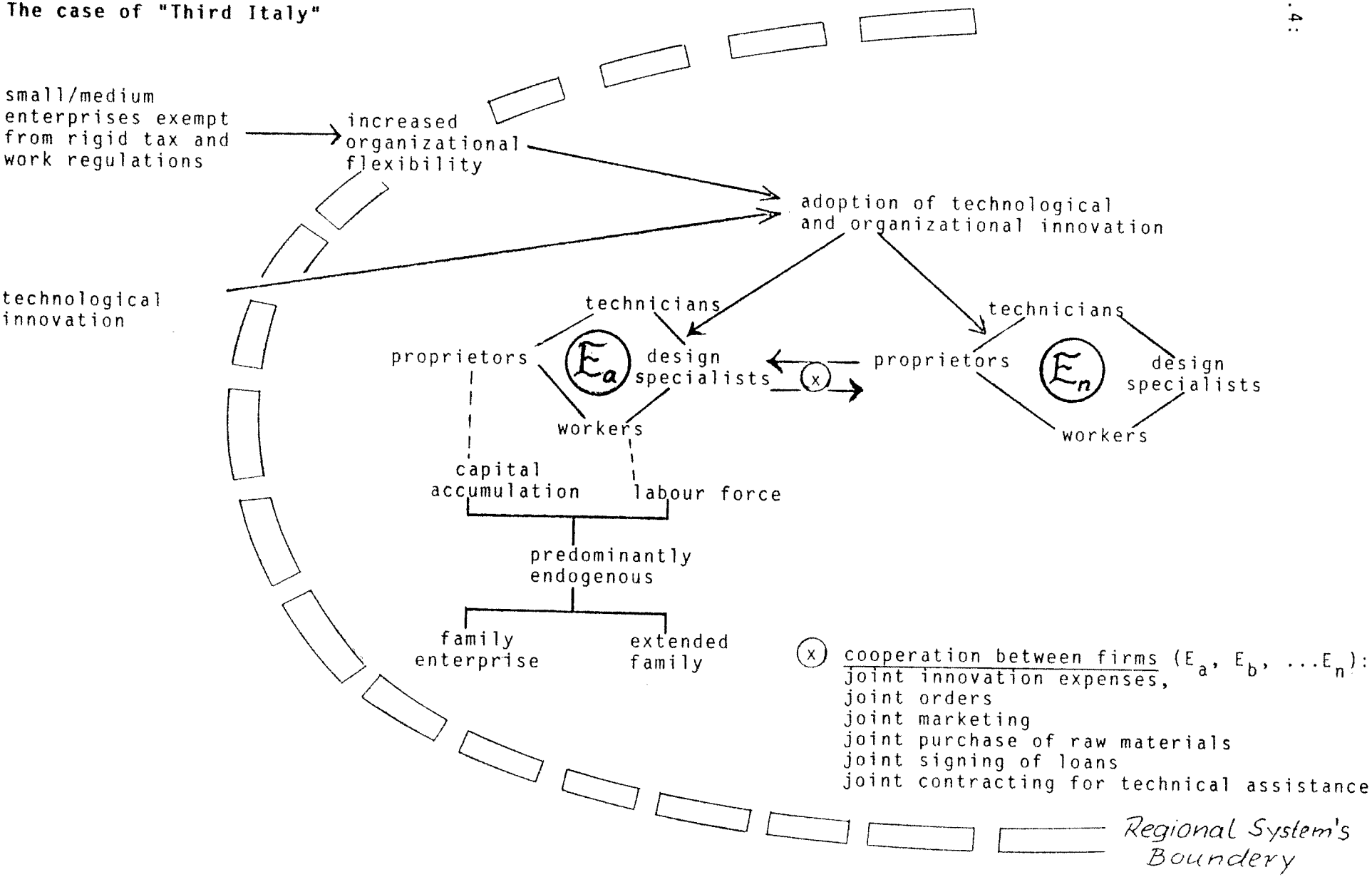
A second important condition for the high innovation rate seems to be an external one, namely the specific legal status under which small shops operate and which does not subject them to the rigid "tax and labour legislation that governs large enterprises" and not only gives them "numerous opportunities for reducing the direct costs of production" but above all increases "the flexibility of their operation" (p. 406). - A further external input is technological innovation which is skillfully adapted to regional and small-scale industrial requirements.

Fig. 4:

TERRITORIAL INNOVATION COMPLEX II: A PRIVATE SECTOR MODEL

(PRIVATE MEDIUM/SMALL ENTERPRISES)

The case of "Third Italy"



Territorial Innovation Complex III: a "third sector" model

Here the case of the Japanese Technopolis policy is used (cf.also Stöhr 1985). A major characteristic is the close interaction at the regional level between local government, local university (mainly science/technological disciplines) and private enterprise (see also Fig.5). Such cooperative structures, neither purely private nor purely government, have in Japan been called "third sector" and have so far existed mainly at the national level.

At the regional level this model was first applied in Japan during the late 1970's upon local initiatives in the then less developed South-western part of the country, the Island of Kyushu. This island had historically been the entrance gate of external religious and cultural influence, initially from China and in the Middle Ages from Europe, but had in Japan's industrialization phase lagged behind and become what was considered economically underdeveloped.

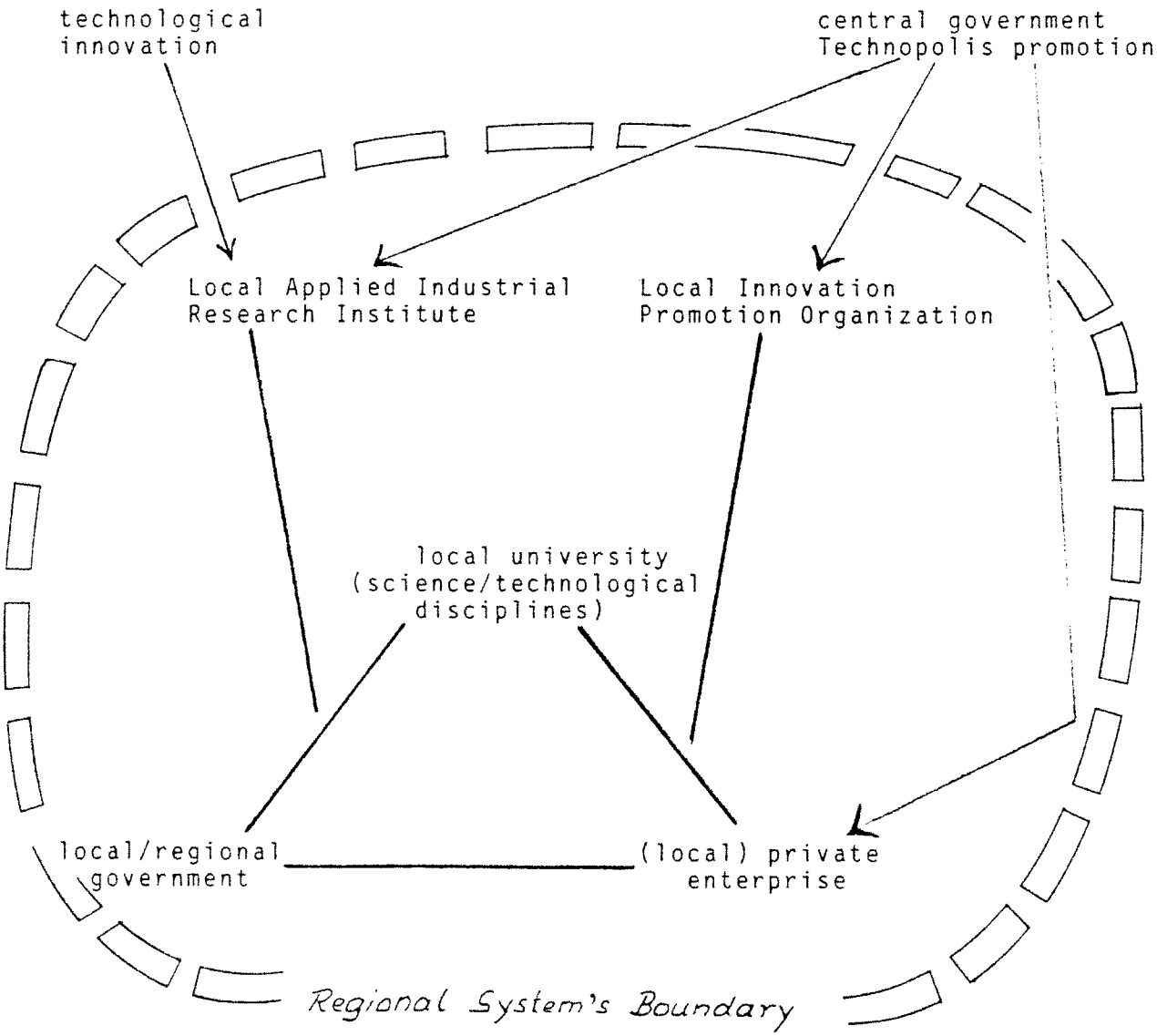
The discrepancy between the consciousness of having been the traditional cultural "heart" of Japan and the recent state of economic underdevelopment gave local politicians the challenge for a new initiative.

The basic idea was derived from the high-technology areas in the USA of the Silicon Valley type and its successors in that and other countries. These foreign pre-cursors have aroused local initatives for the promotion of high-technology industries first in the Prefecture of Oita (total pop. 1,2 mill. inhab.) on Kyushu Island. There the local Prefect, a former MITI functionary, in the 1970's already had undertaken initiatives to attract electronics firms and esta-

Fig.5:

TERRITORIAL INNOVATION COMPLEX III: A "THIRD SECTOR" MODEL
(local government - local university - local enterprise)

The Japanese Technopolis policy



blished an International Information Center.
Similar initiatives successively were also undertaken by the neighbouring Prefecture of Kumamoto and then by the other Prefectures of Kyushu Island.

The list of firms which established plants in these Prefectures of Kyushu Island reads like a Who-is-Who in high-technology industries. Today close to 40 % of Japanese production of integrated circuits are located on this island. Initially they were branch plants of large U.S. and Japanese firms, but successively also small and medium-sized local firms were established and benefitted from these initiatives. In spring 1984 then a local "Advanced Technology Research Center" and a "Regional Technology Promotion Foundation", both of the "third-sector" type described above, had been created in Oita. Particularly the first is to serve SME development. The basic Technopolis structure in Japan therefore essentially is based on regional initiative, though in various respects inspired from outside.

The central government has subsequently attempted to multiply such local initiatives and stimulate them also in other parts of the country. At the same time it has tried to institutionalize them in different regions by stipulating the creation of a Local Innovation Promotion Organisation and of a Local Institute for Applied Industrial Research, constituted by local (prefectural) government, local university and local private enterprise (cf. Fig.5). These two types of local institutions are the prerequisite for the formal designation of a Technopolis area and for the exten-

sion of further central government aid to them. These local institutional structures are considered catalysts for a self-sustaining local innovation process.
Within one and a half year after the passage of a national "Law for Accelerating the Regional Development based upon High-Technology Industrial Complexes (Technopolis Law)" in July, 1983, close to 20 such Technopolis projects had been prepared at the local level, of which, by the end of 1984, 14 had already been approved for central government support. These Technopolises have to be outside the major metropolitan areas and are distributed along the entire length of Japan (Stöhr 1985). In this way they represent a national system of decentralized high-technology nuclei.

The extent of local initiative is shown by the fact that in 13 areas later designated as Technopolises, during each of the two years preceding the passage of the Technopolis Law, a total of about 85 new plants had already been established. The additional effect of this national policy can be assessed from the fact that in the year following the passage of the Technopolis Law the number of new plants established in these 13 areas increased by about 1/2 to a total of 128, and that in each of these areas (except one) the annual number of newly established plants was greater than before the passage of the Technopolis Law (Stöhr 1985).

It is important to note that these Technopolises signify not only technological but also institutional innovation (the local Technology Research Centers and the Technology Promotion Organizations), triggered mainly by local/regional

initiative. The central government provides, by a well designed set of instruments described elsewhere (Stöhr 1985), a favourable environment and subsidiary support for this local innovation.

8. SOME CONCLUSIONS

A number of conclusions can be drawn from this paper:

- Innovation is a complex phenomenon which requires technological, institutional and social change. The existence (or provision) of single factors to promote innovation - e.g. public research institutes, knowledge centers, management consulting services, venture capital firms, etc. - therefore usually is not a sufficient condition for the actual emergence of innovation.

- Regional innovation is often triggered by external pressure (structural instability, sectoral competition, etc.) and inspired by external examples, but in order to become a self-sustaining process requires specific intra-regional synergetic processes and structures, similar to what Colombo and Lanzavecchia (1985) call a "scientific apparatus" in which "technology is born and develops as a form of scientific knowledge in itself in a close interaction between science, industry, information, education, financing and government" at the regional level.

- The emergence of innovation is not restricted to highly developed core regions where interaction and synergy

usually are considered to be highest, but - as case studies show - under certain conditions can also take place in other regions such as peripheral areas or structurally weak industrial areas.

- It has historically been shown that if such synergetic interaction is missing, even core-areas with initially high rates of technological inventions will not innovate (Colombo and Lanzavecchia, 1985, quote the case of England towards the end of the 19th century as example). Countries or regions possessing such synergetic interaction structures, however, have often been able to innovate even if their initial rate of inventions was comparatively low (e.g. the case of Japan after WW II). The reason seems to be that only with the availability of the forementioned "scientific apparatus" of interacting institutions it is normally possible effectively to apply inventions and adopt technology to different (regional) socio-economic and cultural conditions.

- The recent process of spatial functional specialization has, particularly in non-metropolitan areas (both of the peripheral rural as well as of the "old" industrial type), led to the disruption of such synergetic interaction networks. For non-metropolitan areas and/or for those with low invention rates the creation of these regional synergetic interaction structures therefore appears as an important prerequisite for innovation. Three relevant case studies for peripheral areas from different socio-economic systems have been analyzed in

this paper.

- Considering these case studies, important components of the forementioned synergetic networks appear to be the regional interaction of: educational and training institutions, R+D, technological and management consulting, risk financing, production, and locally rooted decision-making functions. This interaction can take place either within or between specialized regional institutions or - if regional institutional specialization has not proceeded that far - also by informal cooperation between (frequently functionally less specialized) small and medium-sized firms as e.g. in the "Third Italy" case study quoted.

- If one or few of the regional functions mentioned above are missing it seems possible to (at least temporarily) substitute them by external ones, provided that regional interaction between the remaining functions is operating. So in the Basque case study quoted the lack of an adequately oriented regional university could temporarily be bridged by contacts with foreign research and university centers.

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