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Regional Differences and Determinants of Entrepreneurial Innovation - Empirical Results from an Austrian Case Study

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FRANZ TÖDTLING

REGIONAL DIFFERENCES AND DETERMINANTS OF ENTREPRENEURIAL INNOVATION - EMPIRICAL RESULTS FROM AN AUSTRIAN CASE STUDY

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ABSTRACT

Increasing international competition has forced manufacturing enterprises in industrialised countries to restructure and to improve their competitive position. An important strategy is to introduce new or modified products and/or processes. There is both theoretical reasoning as well as some evidence that regional economies differ in their ability and propensity to innovate.

The paper discusses first theoretical approaches and explanatory factors for regional innovation. Then some empirical evidence with regard to the innovation activity of plants (introduction of new products and processes) in selected Austrian regions is presented, mainly based on interviews in about 150 plants. The sectors analysed are metalworking, machinery, electrical products and electronics. The investigated regions are the capital region of Vienna, two industrialised regions (one of them an "old" industrialised region) and two peripheral rural regions.

The analysis shows that there are considerable regional differences with regard to the introduction of product-innovations classified as "new to the market" as well as to some of the new processes (e.g. the more recent technologies such as CAD). In general a higher innovation activity could be observed in the agglomeration of Vienna as well as the "younger" industrialised region of Vöcklabruck. Innovation activities were rather low in the old industrial Obersteiermark and the peripheral rural Waldviertel.

In the PROBIT-analysis it was found that the innovation activity of the plants was to a high degree determined by their structural and behavioural features: There were significant internal factors such as the functions performed (R&D and marketing), the qualification of the labor force and the kind of production process (length of production runs). There were also external factors such as the export orientation, the competitive position and the technical economic contacts. Locational factors had some but not much direct influence on the innovation activities of plants. The regional innovation differences thus were to a high degree due to the historically evolved regional economic specialization. The results therefore suggest that regional innovation policy should be integrated with the long run structural improvement of regional economies.
CONTENT

1) Introduction

2) Theoretical aspects
   
   2.1 Locational factors of entrepreneurial innovation
   2.2 Regional specialisation of plants and innovation

3) Results from an Austrian case study

   3.1 Background of the empirical study
   3.2 Structural characteristics of investigated plants
   3.3 Regional differences in innovation activity
   3.4 Results from the PROBIT analysis

4) Summary
1) Introduction

A changing international division of labor and changing macro-economic conditions have reinforced entrepreneurial competition in industrialised countries since the early seventies and have consequently speeded up industrial restructuring. In the course of this restructuring process many firms try to increase their competitiveness by taking one or more of the following strategies and measures (Massey and Meegan 1982, Tödtling 1986, Stöhr 1987a): (1) Cost cutting measures such as the reduction/closure of unprofitable productions, the concentration of production into the more efficient plants, the relocation to cheaper locations, the introduction of a more efficient organisation ("intensification" of production) or the introduction of cost saving new technology; (2) search for new markets via market penetration/extension, the modification of existing products or the introduction of new products; (3) flexible adjustment to specific demands (e.g. subcontracting or "custom tailoring"). Technological change and innovation (in the broad notion of Schumpeter) plays an important role in most of these strategies and thus seems to be of general importance for the improvement of the competitive position of plants.

In the Austrian context there are two spatial levels with regard to problems of entrepreneurial innovation: For the country as a whole a "backwardness" compared to other industrialised countries has been observed (low levels of R&D, unfavourable balance of patents/licenses, above average share of mature and basic products in the economy: Volk 1987). At the regional level there has been some indication (evidence of industrial R&D activities) that striking differences with regard to entrepreneurial innovation exist (Tödtling 1987). Up to now, however, there has been no systematic analysis of this latter aspect.

In the following the focus will be on the regional differences of entrepreneurial innovation, particularly the introduction of new products and processes at the plant level. At first theoretical aspects and concepts which indicate explanatory factors will be discussed. Then some empirical evidence from five Austrian regions will be presented based on interview data in selected industries (metalworking, machinery
and the electrotechnical industry). The regions investigated are (1) an area within the agglomeration of Vienna, (2) a dynamic industrialised area (Vöcklabruck), (3) an "old" industrialised area (Obersteiermark) and two peripheral rural areas, (4) Süd- und Oststeiermark and (5) Wald- und Weinviertel. The empirical evidence will be related to (a) relevant structural characteristics of plants, (b) innovation activities (introduction of new products and processes), and (c) results of a PROBIT-analysis with regard to determining factors.

2) Regional differences in entrepreneurial innovation - theoretical aspects

Up to now there has been no consistent theory of regional innovation, but there are several concepts which indicate explanatory factors. In general these explanatory approaches relate to the following context (Ewers et al. 1980, Thwaites 1982, Cappellin 1983, Brugger and Stuckey 1987, Tödtling 1988):

- location factors
  - qualification of labor force
  - information density & contacts
  - infrastructure (education, research, communication)

- entrepreneurial innovation
  - products
  - processes

- regional ec.specialisation (structural characteristics)
  - industries
  - product cycle
  - functions
  - org.status of plants
  - behavioural types
Some early approaches of innovation diffusion have placed stress strongly on the importance of location factors: the diffusion process was seen as being mainly determined by the transmission of information between suppliers or early adopters and potential adopters, depending on factors such as the hierarchical or geographical distance between them or the size of agglomeration. These approaches have neglected economic factors - internal and external to the plant - and thus have little explanatory power. In the following a brief survey of more recent approaches and concepts will be given, indicating relevant factors of influence. These refer to both locational factors as well as structural characteristics of plants.

2.1 Locational factors of entrepreneurial innovation

The following locational factors have been considered as relevant for entrepreneurial innovation in the literature (Ewers et al. 1980, Malecki 1983, Aydalot 1986, Stöhr 1987b, Brugger and Stuckey 1987, Davelaar and Nijkamp 1987):

* Factors related to the qualification of the labour force such as the availability of qualified labor (particularly technical and economically well trained personnel); the quality of the educational system (technical and management schools and universities) and the general quality of living for highly skilled labor (cultural and leisure facilities, environmental quality);

* Information density and contact potential: these are mainly determined by the access to research facilities and universities, the access to private and public services for information transmission (producer services, "diffusion agencies" for specific technologies) as well as the density of economic activities and the linkages existing between them;

* "Innovation-relevant" infrastructure such as facilities for telecommunication as well as for rapid transport (allowing personal contacts: air connection, rapid train).

The availability of venture capital has also been considered as a locational factor for innovation, but more recent studies have pointed out, that this factor is important rather at the national than at the local or regional level (Ewers et al. 1980,
Some authors have argued, that it is not the availability of single of these location factors but the **interaction of all of them** which is important (synergy effects, "milieu": Aydalot 1986, Perrin 1986, Stöhr 1987b, Aydalot and Keeble 1988). These milieu-effects partly have to do with the "technological capabilities of a region" which result from informal contacts and processes, learning by watching, doing and using as well as "tacit knowledge" of the people in the region (Malecki 1988). Also socio-political and cultural factors have been considered to have an influence on the innovation process (Aydalot 1986, Maillat and Vasserot 1986). These synergy and milieu effects as well as the latter cultural factors - although probably very important - are difficult to operationalize and to measure at the empirical level, however.

It should also be pointed out that the relative weight of the above stated locational factors differs for various kinds of innovation as is suggested in the product cycle theory. In general they are considered more important for product innovations (the more radical the innovation the higher the locational requirements) and less important for minor modifications of products and process innovations (which are very often bought with the machinery). The latter process innovations are furthermore considered to depend on specific information networks, "diffusion agencies" or service networks (Brown 1981, Müdespacher 1987).

### 2.2 Regional specialisation of plants and innovation

Besides the direct impact of location factors on entrepreneurial innovation, the existing regional specialisation (structural characteristics of plants) determines the innovation activity. The following concepts have relevance in this context (Ewers et al. 1980, Thwaites 1982, Cappellin 1983, Brugger and Stuckey 1987, Tödtling 1988, see also Fig.1):

* **Sectoral characteristics**: Sectors or "industries" are the relevant economic environment of the plant/firm and they differ with regard to the growth of demand, the
degree of competition and of market concentration (Scherer 1980, Porter, 1980). They also differ in the technological opportunities and dynamics and thus in the average amount of R&D spent and the general importance of innovation. High technological dynamics have been observed in the past years e.g. in the sectors penetrated by micro-electronics (Freeman 1982). For Austria it has been shown that a considerable share of regional R&D differences is due to the sectoral composition of regional economies (Tödtling 1987).

* **Product cycle characteristics:** It is argued that products go through a life cycle (stages) in the course of which markets as well as factor requirements and the optimal location change (Erickson and Leinbach 1979, Suarez-Villa 1983). In the course of the cycle the typical innovation pattern (kind and intensity of innovation activity as well as their location) also changes (Utterback 1979). Furthermore there is a strong relationship between product and process innovations. The spatial pattern of innovation is expected to be concentrated in the early stage of the product cycle (product innovations) and more dispersed in the growth and mature stages, in which product modification and process innovation are dominating. The final stage of the cycle is characterised by a lack of innovation activity.

* The concept of the **functional specialisation of plants** considers activities outside the direct production activities - particularly the "boundary spanning" functions R&D and market-related functions - of central importance for the innovation process and also for regional development. Regional differences in innovation are seen mainly as a consequence of a spatial concentration of these functions (Ewers et al. 1980, Bade 1984, Brugger and Stuckey 1987).

* **Organisational characteristics of plants:** The affiliation of plants to larger multiregional enterprises may furthermore be relevant in the innovation process. These plants on the one hand have access to resources of the larger enterprise (financial resources, R&D, market networks, planning departments and information networks). On the other hand they are subject to an internal division of labour in the firm, which may be detrimental particularly to peripheral branch plants (Watts 1981, Thwaites 1982, Gibbs and Edwards 1982, Massey 1984, Tödtling 1984, Holst 1987). In general it is expected that the branch plants have low product innovations. With regard to new production processes, however, they are - due to their in-
tegration into a larger enterprise - considered to be earlier adopters than e.g. the single plant enterprises. **Single plant enterprises** on the other hand are much more dependent on the quality of their immediate locational environment, also with regard to innovation activities. It is argued that they face disadvantages in this context particularly in old industrial as well as in peripheral rural areas (Thwaites and Oakey 1985, Goddard et al. 1986, Grabher 1988).

* **Firm size** and the **size of the plant** have been considered as important for entrepreneurial innovation since the writing of Schumpeter (Schumpeter 1934, Freeman 1982, Kleine 1983). While firm size is reflected in the organisational aspects discussed above, the size of the plant may have an additional influence, although the arguments are ambivalent: On the one hand large plants have more financial and other resources for introducing costly new products and processes (Gibbs and Edwards 1983, Rees et al. 1984), on the other hand it is argued that they have more bureaucratic organisations and may be lacking intensive lateral and informal information flows which are considered important in the innovation process (Burns and Stalker 1968, Sorge 1986).

* **Skills of the work force** have already been mentioned in the locational context, their importance, however, becomes manifest internally to the plant. They reflect the level of "competence" in the plant which can be regarded as a precondition both for the introduction of new products as well as of new processes (Andersson and Johannson 1984, Johannsson and Larsson 1986). The introduction of specific new technologies furthermore depends on the **existing production processes** in the plant: e.g. the CNC as well as CAD technology is, because of its flexibility, particularly suited for medium-sized production runs, less for unit- or for mass-production (Gibbs and Edwards 1983).

* **Firm strategy and innovation**: Some authors like Freeman (1982) as well as behavioural geographers (Taylor and Thrift 1983, Taylor 1983) have stressed the fact that firms differ (explicitly or implicitly) in their strategic position which they take within the economy (strategic or behavioural types of firms). It is argued that only for some of these behavioural types innovation and technological change is of crucial importance, e.g. those which pursue "offensive" or "defensive" innovation strategies, to a smaller extent for those pursuing imitative strategies. For other seg-
ments (having e.g. "dependent", "traditional" or "opportunistic" strategies) it is of little relevance. In the following empirical analysis this behavioural dimension was operationalised by several variables: dependence on large customers (subcontracting), extension of the market (export-rate), competitive position of the firm (technological advantages versus price advantages), the amount of technical-economic contacts and the subjective attitudes of management to innovation.

Besides the locational and structural factors the entrepreneurial innovation process is influenced by public innovation policy: Like in most market economies also in Austria the state tries to promote and stimulate innovation activities in the economy by giving financial support or advice to firms, or by promoting the development and diffusion of specific technologies. In Austria exist several programs and institutions which provide financial support to the development and introduction of new products: within the "TOP" program soft loans for the introduction of new products are given; a funds for research and development ("FFF") provides subsidies to R&D activities of firms; there are also institutions concerned with the information transmission in the innovation process (at the federal level e.g. "Innovationsagentur"); and there exist programs for the development and application of specific technologies (microelectronics, biotechnology). Firms which can get support from these programs may find it easier to overcome financial and other bottlenecks in the innovation process. Up to now there is little regional dimension in this public innovation policy.

The following fig. 1 summarises the factors for regional innovation which have been discussed. The innovation activities of plants can be seen - with reference to organisational science and behavioural theory - as being influenced by the relations of the plant to its relevant "environment" (economic, institutional/political, locational) as well as by its internal characteristics. Because of the regional and theoretical perspective chosen, the main focus here is on these structural factors of plants. Subjective factors such as management style and attitudes of managers and employees or factors such as the more differentiated internal organization of plants and enterprises have been neglected in this approach.
Fig. 1: FACTORS INFLUENCING ENTREPRENEURIAL INNOVATION

LOCATION FACTORS
- qual. of labor force
- contacts & info.
- infrastructure

Size of plant
- functions (R&D, Marketing)
- skills of work force
- kind of prod. process
- product cycle characteristics
- subjective factors (attitudes of management and workforce to innovation)

Amount and kind of entrepreneurial innovation
(product- and process innovation)

Public innovation policy

Economic environment of plant
- industry (technolog. turbulence)
- affiliation to multi-loc. firm (org. status)
- markets competitive position
- technical/economic contacts

Internal characteristics

Subjective factors

Location factors

Size of plant

Entrepreneurial innovation

Public innovation policy

Subjective factors

Location factors

Size of plant

Entrepreneurial innovation

Public innovation policy

Subjective factors

Location factors

Size of plant

Entrepreneurial innovation

Public innovation policy

Subjective factors
3) Results from an Austrian case study

3.1 Background of the empirical study

The following results are based on interviews in 149 plants of the industries metal and steel products, machinery, electrical products and electronics in five Austrian regions. These sectors have been selected because technological change - due to the penetration by microelectronics - plays a major role. The regions have been chosen according to their - a priori assumed - differences with regard to locational and structural preconditions for innovation (see description below and map 1): (1) A case study area within Austria's largest agglomeration Vienna ("Wien-Süd"), (2) a more dispersed but dynamic industrialised area ("Vöcklabruck"), (3) an "old" industrialised area "Obersteiermark", and (4)/(5) two peripheral rural areas ("Südsteiermark" and "Waldviertel").

In the investigated sectors and regions all plants which had more than 20 employees were asked for an interview, 149 plants (more than half) with about 30500 employees were finally covered, they represent from 45% to 70% of the employment in the respective sectors and regions. The data have been collected by interviews with the managers or owners of the plants in spring and summer 1987. The interviews have been conducted by the author (Südsteiermark), the students H.Hofer (Waldviertel), A.Strasser (Vöcklabruck), M.Weinrother (Wien-Süd) as well as H.Glatz from the Institute of Advanced Studies (Obersteiermark). They were based on a questionnaire covering the following aspects:

* basic characteristics of the plant (age, organisational status/ownership, employment, sales and the respective changes);

* qualification of employment and functions performed;

* characteristics of product (age, product cycle), markets (spatial extension, concentration of customers) and production processes (lot size);

* introduction of new products and processes (kinds, motives, objectives, sources and problems);

* kind and spatial extension of technical-economic contacts;
Map 1: INVESTIGATED AREAS

1) Wien-Süd (Liesing, Industriezentrum NÖ-Süd)
2) Vöcklabruck-Gmunden
3) Obersteiermark
4) Süd- und Oststeiermark
5) Wald- und Weinviertel
satisfaction with location factors (in general and with respect to innovation).

In the Obersteiermark a shorter questionnaire was used and not all of these aspects were included with the same level of detail.

3.2 Characteristics of the investigated regions and plants

The investigated regions differ - due to their selection - with regard to general locational and economic preconditions for innovation such as the qualification of the labor force, the contact and information potential, infrastructure, sectoral structure and overal dynamism. They, however, also show considerable differences with regard to the structural features of the investigated plants in the selected sectors concerning the industrial composition within the chosen sectors, size, organizational status and ownership, functions performed, qualification of employment, age of products, extension and concentration of markets and kinds of production processes as well as the intensity of technical-economic contacts. Only a summary of the characteristics of the region, as well as of the structural features of the investigated plants can be presented here.

(1) Wien-Süd

This case study area consists of the industrial areas "Liesing" and "Industriezentrum-Süd" in the south of the Vienna agglomeration: Being the capital of the country, the agglomeration is well endowed with the above stated locational factors for innovation such as the availability of highly qualified labor, research centers and universities, technical and management schools and producer services.

Regarding the investigated plants (27 plants, 5950 employees), the machinery industry and the electrotechnical industry have a high share of employment. There are, compared to the other regions, relatively more subsidiaries (mostly of foreign firms), main plants of multiregional firms and endogenous plants and, in general, the plants are older, larger and organisationally more differentiated. They have
more R&D as well as marketing functions (in terms of full-time equivalents) and a clearly better qualified labor force (higher shares of qualified commercial and technical personnel). Also the technical contacts are more frequent as well as more specialised.

(2) Vöcklabruck

This area - consisting of the districts of Vöcklabruck and Gmunden - is a relatively dynamic industrialised area with a dispersed settlement structure and rather small and medium sized plants. The area contains no larger regional center, but has good accessibility to the agglomerations Linz and Salzburg and also to the dynamic region of Munich and to the European market.

The investigated plants (37 plants, 6240 employees) belong more often than the sample-average to the machinery industry and are also more often endogenous, main plants of multiregional firms or subsidiaries, whereas there are only few branch plants. Similar to Wien-Süd the plants have more dispositive functions (planning, marketing, R&D), a higher qualification of the work force (technicians, commercial staff) and also more technical contacts than the plants in the rural areas and the old industrial Obersteiermark.

(3) Obersteiermark

This is an "old" industrial area - based on iron and steel and a high importance of state owned enterprises. It is fairly monostructured, has a considerable share of its employment in branch plants of large firms and a lack of producer services. The region faces economic decline and increasing unemployment.

Because of the tradition of iron and steel in the region, the investigated plants (29 plants, 6940 employees) are - compared to the other regions - also more often in metal working and steel products. Because of the exclusion of the two large state owned enterprises (branch plants of VOEST-ALPINE and VEW) a high share of the plants in the sample is formally autonomous, but many of them are subcontractors to Austrian and German firms and some are in public ownership. Most of these firms also have a low level of R&D and marketing activities. Concerning
the qualification of the employees there is a lack of higher commercial and technical staff but - different from the rural areas - a high share of skilled blue collar workers. Some of the larger plants are in crisis and restructuring and have lost a considerable amount of their employment.

(4) Südsteiermark

This is a rural area, peripheral to the national and European markets, but with a good accessibility to the regional center Graz. The latter is a medium sized agglomeration of about 300,000 which is well endowed with schools, university, producer services and information networks. The investigated area has a typical "rural" industrial structure (apparel, electrical products, some traditional industries for the regional market). There has been some industrial dynamism in the past 20 years partly due to the establishment of branch plants and (very often foreign) subsidiaries, which in many cases have been supported by regional policy.

The investigated plants (29 plants, 7720 employees) show in many respects similar features as those in the below characterised Waldviertel. There are two different segments: on the one hand small endogenous plants, very often in metalworking and machinery, on the other hand larger externally controlled plants, very often in the electrotechnical industry. Both segments lack important functions (planning, R&D, marketing) and they have a low qualification of the labor force. Compared to the Waldviertel there is, however, a stronger penetration by extra-regional and foreign firms and a higher share of plants in "modern" electronic industries. Due to this fact, there is more mass-production, a higher level of productivity, shorter product-cycles and a higher share of technicians than in the Waldviertel. The plants also show more technical contacts, very often to the regional center of Graz.

(5) Waldviertel

This is also a rural area, but it is even more peripheral that the above region: large parts of this area have, in contrast to the Südsteiermark, a very low accessibility to larger centers (Wien, Linz) and there is generally a low density of activities. The region has some older industries (textiles, glass, stone, wood) and has also attracted new plants in the 1960'ies and early 1970'ies (mainly labor intensive indu-
stries such as apparel and electrical products).

The investigated plants (27 plants, 3570 employees) consist - like in the Südstei-
ermark - of two rather different segments: On the one hand small plants in metal and steel products or (agricultural) machinery are represented more strongly. They are very often older endogenous plants and subcontractors to larger enterprises outside the region, and in general have a low productivity. On the other hand there are some larger plants in the electrotechnical industry which absorb almost 2/3 of the employment of the investigated plants. The latter are mostly branch plants in the more mature stage of the product cycle and are subject to a well articulated division of labor within the respective firms. Both segments lack important functions such as R&D, marketing and planning and consequently they also have a very low qualification of the labor force (low shares of technical staff and management personnel and high shares of unskilled female workers). Furthermore their level of technical contacts is low.

3.3 Regional differences in innovation activity

The managers of the plants were asked to indicate the innovations which have been carried out in the previous years (1981-1986). "Innovations" were defined to include the opening up of new markets with existing products (market expansion or penetration), the introduction of new products (both "new to the market" as well as "new to the plant"), the modification of products and the introduction of new processes (in the production and in the office). Some of the results will be presented in the following.

a) Product innovations

About 4/5 of the plants have stated that they carried out some kind of product innovations. This rather high share is due to the fact, that a long period (5 years) has been asked and that all kinds of new products are included. The differences between regions with regard to this general indicator were not very strong. More and
significant differentiation could be seen for those product innovations which were considered as "new to the market" by the respective managers (see table 1):

Table 1:

<table>
<thead>
<tr>
<th></th>
<th>Product innovation &quot;new to the market&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% of plants</td>
</tr>
<tr>
<td>Wien-Süd</td>
<td>67</td>
</tr>
<tr>
<td>Vöcklabruck</td>
<td>49</td>
</tr>
<tr>
<td>Südsteiermark</td>
<td>55</td>
</tr>
<tr>
<td>Waldviertel</td>
<td>30</td>
</tr>
<tr>
<td>Obersteiermark</td>
<td>17</td>
</tr>
<tr>
<td>All areas</td>
<td>44</td>
</tr>
<tr>
<td>Contingency coeff.</td>
<td>0.33</td>
</tr>
<tr>
<td>Probability of $\chi^2$</td>
<td>0.001</td>
</tr>
</tbody>
</table>

In Vienna 2/3 of the plants have reported these kind of product innovations. They are of large size, employing 94% of the respective work force. Also the plants of the industrialised region of Vöcklabruck as well as the rural Südsteiermark were fairly active in this regard. In the case of Vienna and Vöcklabruck the higher product innovation activity is in line with the better preconditions which were presented above (both locationally as well as with regard to the structural characteristics of the plants). In the Südsteiermark the high product innovation activity was not expected: both subsidiaries and branches from multilocational enterprises (mainly in the electrotechnical/electronics industry with typically short product cycles) as well as small endogenous enterprises (mainly in the machinery sector) are involved. These latter firms very often are former producers of agricultural machinery which benefit from the technical skills of the owner manager and the work force. These are often informal qualifications resulting from training on the job. They also seem to benefit from the "strength" of the regional center (Graz) in the engineering sector and the technical research infrastructure (technical university, research centers, enterprises).

This kind of product innovation was very low in the old industrial area of Ober-
steiermark (only 17% of the plants with just 7% of the employment) as well as in the peripheral rural Waldviertel (30% of the plants). In the latter region the innovative plants are large (mainly electrotechnical industry) - they employ 60% of the labor force.

In the case of the modification of existing products the regional differences are also significant and the ranking of the regions stays about the same: The plants in Wien-Siid and Vöcklabruck are again more active (more than 70% of the plants with about 90% of the employment). Those in the old industrial area (Obersteiermark) are clearly below average (table 2).

Table 2:

<table>
<thead>
<tr>
<th>Region</th>
<th>% of plants</th>
<th>% of employment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wien-Siid</td>
<td>70</td>
<td>89</td>
</tr>
<tr>
<td>Vöcklabruck</td>
<td>78</td>
<td>89</td>
</tr>
<tr>
<td>Südsteiermark</td>
<td>66</td>
<td>72</td>
</tr>
<tr>
<td>Waldviertel</td>
<td>63</td>
<td>69</td>
</tr>
<tr>
<td>Obersteiermark</td>
<td>28</td>
<td>33</td>
</tr>
<tr>
<td>All areas</td>
<td>62</td>
<td>71</td>
</tr>
<tr>
<td>Contingency coeff.</td>
<td>0.34</td>
<td>0.45</td>
</tr>
<tr>
<td>Probability of 𝛹²</td>
<td>0.001</td>
<td>0.001</td>
</tr>
</tbody>
</table>

These results for the product innovation activity are fairly consistent with the data about the age structure of the products (number of years in production program): The "youngest" product structure was in the "innovative regions" Wien-Siid, Südsteiermark and Vöcklabruck, the oldest in Obersteiermark and Waldviertel.

b) Introduction of new processes

As in the case of product innovations there was very little and insignificant regional differentiation with regard to the introduction of new production processes in ge-
eral. In all regions between 78% and 83% of the plants have indicated to have introduced some kind of new production processes in the past five years. The old industrial area (Obersteiermark) is - in contrast to the low product innovation activity - not below average with regard to this indicator (table 3).

Table 3:

<table>
<thead>
<tr>
<th>Region</th>
<th>General</th>
<th>CNC*</th>
<th>CAD*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wien-Süd</td>
<td>78</td>
<td>44</td>
<td>41</td>
</tr>
<tr>
<td>Vöcklabruck</td>
<td>78</td>
<td>38</td>
<td>11</td>
</tr>
<tr>
<td>Südsteiermark</td>
<td>83</td>
<td>38</td>
<td>14</td>
</tr>
<tr>
<td>Waldviertel</td>
<td>78</td>
<td>19</td>
<td>11</td>
</tr>
<tr>
<td>Obersteiermark</td>
<td>79</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>All areas</td>
<td>79</td>
<td>35</td>
<td>18</td>
</tr>
<tr>
<td>Contingency coeff.</td>
<td>0.05</td>
<td>0.19</td>
<td>0.30</td>
</tr>
<tr>
<td>Probability of ( \chi^2 )</td>
<td>0.99</td>
<td>0.21</td>
<td>0.008</td>
</tr>
</tbody>
</table>

*) These were not asked in the region of Obersteiermark.

There was more regional differentiation with regard to specific technologies such as CNC and particularly CAD. These technologies were to a higher degree introduced in Wien-Süd (44% and 41% of the plants). Clearly below average in the case of CNC was the region of Waldviertel, in that of CAD all three other regions. The regional difference in the diffusion was thus much more pronounced in the case of the newer CAD technology than in the older CNC (tab.3).

The introduction of information technology in the office also shows some regional differentiation (table 4): Concerning the introduction of computers the peripheral Waldviertel and the Obersteiermark were below average, the regional differences, however were not significant. The latter was the case for the new communication technologies: again the Obersteiermark as well as Vöcklabruck were below average. These results indicate a technological backwardness in the offices of the plants particularly in the old industrialised Obersteiermark, partly also in the peripheral
Waldviertel (computers) and in Vöcklabruck (new communication technologies).

Tab. 4:

Information technology in the office (% of plants)

<table>
<thead>
<tr>
<th></th>
<th>computers</th>
<th>new comm. technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wien-Süd</td>
<td>63</td>
<td>78</td>
</tr>
<tr>
<td>Vöcklabruck</td>
<td>70</td>
<td>51</td>
</tr>
<tr>
<td>Südsteiermark</td>
<td>76</td>
<td>79</td>
</tr>
<tr>
<td>Waldviertel</td>
<td>52</td>
<td>70</td>
</tr>
<tr>
<td>Obersteiermark</td>
<td>52</td>
<td>28</td>
</tr>
<tr>
<td>All areas</td>
<td>63</td>
<td>65</td>
</tr>
<tr>
<td>Contingency coeff.</td>
<td>0.20</td>
<td>0.25</td>
</tr>
<tr>
<td>Probability of $\chi^2$</td>
<td>0.21</td>
<td>0.038</td>
</tr>
</tbody>
</table>

In a further step of the analysis determining factors of innovation activities have been investigated mainly by two approaches: (1) questions were included with regard to (subjectively indicated) "sources and obstacles" to innovation; (2) statistical methods (crosstabulation-statistics as well as a multivariate probit analysis) have been applied. Some of the results of the latter PROBIT analyses are summarized in the following.

3.4 Results from the PROBIT-analysis

Up to now there have been only a few attempts to analyse entrepreneurial innovation activities at the regional level in a multivariate framework (see e.g. Alderman et al. 1983, Johannsson and Larson 1986, Wrigley and Brouwer 1986). In the present study a PROBIT-analysis was applied, investigating the probability for the introduction of selected innovations at the plant level depending on a set of explanatory variables (see Tödtling 1988). Gunther Maier gave advice with regard
to methodological aspects and wrote the necessary computer programs (linked to the SAS statistical package: Maier 1987).

The PROBIT-analysis - as applied here - has many similarities with a conventional multivariate regression analysis. As a basic difference the PROBIT-analysis takes into account the fact, that the dependent variable is a binary one. In that case the conventional regression analysis is confronted with several problems (e.g. heteroscedasticity: see Ben-Akiva and Lerman 1985). In the PROBIT-analysis of the present study each plant is seen to have the alternative to introduce a specific innovation or not. The probability of introduction is determined a) by attributes which are specific to the alternative (these are in the present model captured by an alternative-specific constant) and b) by characteristics of the decision making unit (plant). These latter explanatory factors are the internal and external characteristics of the plant which have been discussed above (see fig. 2). In the estimation procedure the explanatory variables were introduced at the beginning simultaneously in the larger set as indicated by fig. 2., then those were stepwise eliminated which contributed only little to the total explanation. Finally the model was chosen, which produced the best fit, taking into account the degrees of freedom (largest corrected). In the estimation a maximum-likelihood procedure has been applied. The search process has been started at a parameter vector which accounts for the observed frequencies of specific innovations. Thus, the \( \hat{\text{v}} \) -values in the figures 3 to 5 only refer to the additional explanatory power of the structural variables (for details see Maier 1987, Todtling 1988). Although the number of cases (149) is not large and of course better results could be obtained from a larger sample, the number is sufficient for this kind of analysis. There have been calculations for several kinds of innovation (product innovations "new to the market", specific process innovations), only a summary of this analysis can be provided here.

Product innovations "new to the market" (fig. 3):

From the external factors the location of the plant in the old industrial "Obersteiermark" (measured by a dummy variable) was significantly negative. In this area the conditions for product innovation are thus worse than in the other regions,
Figure 2: SCHEME OF INVESTIGATED RELATIONS IN THE PROBIT ANALYSIS

Figure 3: PRODUCT INNOVATION "NEW TO MARKET"
(Coefficients and T-values)

\[ \hat{\beta} = 0.38 \quad \text{corr.} \hat{\beta} = 0.26 \quad 9 \text{ variables} \]
even if the other factors are controlled for. It seems that this fact has only partly to do with locational factors such as contact potential, access to universities and research institutions since these are even worse in the rural areas. The socio-economic conditions such as the existence of rigid and bureaucratic organisations (both in enterprises and unions), "conservative" (in the literal sense) attitudes of management and workforce as well as the traditional expectation of outside help (government) seem to be important.

The status as an endogenous plant also had a negative influence on this kind of product innovation: This may be due to the fact, that these are usually smaller firms which lack financial and other resources for product innovation and cannot rely on a network of a larger enterprise.

The fact that the plant has received support from public innovation policy had a positive influence on this kind of innovation (not on others). In most cases this support was financial aid for the development of products and/or the start up of production. The result indicates that the public support was helpful in overcoming financial bottlenecks in the innovation process and that the impact of these programs is at least in the intended direction. The role of financial bottlenecks as a limit for innovation projects also appears in the negative effect of the internal factor "financial obstacles to innovation" (fig.3).

In another version of parameter estimation, in which the plants of the Obersteiermark were excluded due to missing data, the amount of technical-economic contacts had an additional positive influence indicating that a strong outward looking behaviour of the plant is favourable for product-innovation.

From the internal factors the "boundary spanning" functions marketing (existence of activity) and R&D (% of employment in full-time equivalents) as well as the share of white collar employees had significant positive influences. Both the positive influence of the above mentioned external contacts and of the internal "boundary spanning functions" and skills thus support the view, that product innovations occur particularly at the interface of external links (information flows) and internal capabilities (functions and skills). Furthermore a young production program (resulting from product innovations of the previous period) had a positive influence,
indicating the continuous character and the existence of learning effects and routines inherent in the innovation process (Nelson and Winter 1982, Lambooy 1986).

**CNC and CAD (fig 4 and 5):**

CAD as the younger and less diffused technology is better explained by the model than CNC. For both technologies the size of the plant as well as the export-intensity are significant factors. The positive effect of the size probably has to do with the relative high cost of the introduction as well as threshold effects (Gibbs and Edwards 1982). The effect of export-intensity probably comes from stronger competition in external markets as well as those plants having generally better information, leading to a more up to date technological standard of the plant.

In the case of **CNC** (fig. 4) in addition to the above factors the kind of production process (length of the production runs) was a significant factor: unit production on the one hand and mass production on the other had negative influences. Both of these lot sizes are considered as suboptimal for CNC technology. Furthermore CNC was less introduced in the **electrotechnical industry** as well as in **branch plants**: In the electrotechnical industry there is less possibility for application in the production process than in the metal-working and machinery industry, in the branch plants the lack of decision making power and/or the division of labor in the firm might lead to an adoption lag (Gibbs and Edwards 1983). A good profit situation of the plant was favourable for introduction of CNC, probable due to the fact that costs and risks involved are taken more readily in a good economic situation of the plant.

In the case of **CAD** (fig. 5) further significant positive influences came from the qualification of the work force (higher level commercial employees, other white collar employees) and an already existing **technological advantage** in the competitive position of the plant - again indicating previous innovation activity and thus the continuous character of the innovation process (Nelson and Winter 1982).
Figure 4: INTRODUCTION OF CNC
(Coefficients and T-values)

INTRODUCTION OF CNC

ELECTROTECHNICAL INDUSTRY

- 0.82
(1.8)

BRANCH PLANT

- 1.7
(2.7)

% EXPORT

0.13
(2.0)

INTRODUCTION OF CNC

CONSTANT

0.78
(1.0)

0.55
(1.8)

0.17
(2.9)

0.70
(1.9)

PROFIT SITUATION

SIZE OF PLANT

(EMPLOYMENT)

-0.08
(1.5)

% UNIT PRODUCTION

% MASS PRODUCTION

"LACK OF TECHNICIANS"
(subj. obstacle)

9 variables

\( r^2 = 0.30 \) corr. \( r = 0.12 \)

\( x \) not significant at the 0.05 level

Figure 5: INTRODUCTION OF CAD
(Coefficients and T-values)

INTRODUCTION OF CAD

% EXPORT

0.18
(2.1)

TECHNOLOGICAL ADVANTAGE

1.5
(2.9)

INTRODUCTION OF CAD

CONSTANT

-4.9
(4.1)

0.15
(2.6)

14.4
(1.8)

3.6
(1.9)

SIZE OF PLANT

(EMPLOYMENT)

% HIGHER LEVEL COMMERCIAL EMPL.

% ELSE WHITE COLLAR EMPL.

"FINANCIAL OBSTACLES"*

\( r^2 = 0.44 \) corr. \( r = 0.25 \)

7 variables
4) Summary

In the investigated sectors and case study regions there were - due to the historically evolved regional specialisation of plants - quite clear differences both with regard to preconditions for innovations (locational factors, structural characteristics of plants) as well as the innovation activity itself. For product innovations classified as "new to the market" as well as for specific process innovations (CAD, less for CNC) the regional differences were particularly strong. They were also noticeable for new information techniques (computers and communication technologies). In general, a higher innovation activity could be observed for the area in the agglomeration of Vienna as well as the industrialised region of Vöcklabruck, partly also for Südsteiermark. These activities were rather low for the old industrial area of Obersteiermark and the peripheral rural Waldviertel.

The most important explanatory factors for the innovation activity found in the PROBIT analysis, were selected structural and behavioural features of the plants. There were significant internal factors such as the boundary-spanning functions performed (R&D and marketing), the qualification of the labor force and the kind of production process (length of production runs). Also external factors ("firm-environment" or "network characteristics") such as the export activity, the kind of competitive position, the information activity and the industry affiliation turned to be important. Locational factors have some direct effect on the innovation activities of plants (particularly via the labor market), but the stronger impact is via the above stated structural features of the plants, which are due to the historically evolved regional specialisation. In other words: most of the plants which are not innovating have adjusted their production program, functions performed, skills of the work force and technology to the lower quality of their regional environment. They have subjectively "no need for innovation" either because they have other survival strategies (subcontracting, flexibility and accuracy with regard to delivery dates, low wages) or because they don't realize it as a problem. Therefore they usually see no "locational" problem for innovation. Of course the relation of a plant to its regional environment is not one way: The plant also shapes the regional environment by its factor demand (e.g. the skill of its labor force) and by the strength of its linkages to other regional firms (e.g. the demand for producer services) and
thus influences the locational conditions for innovation in the medium and long run.

Due to this longrun interrelated adjustment process and the stability of structural features and behavioural patterns it appears in general quite difficult to change the innovative behaviour of plants and firms in regions with low innovation activities. The stimulation of plants to increase their innovation activities just by the supply of finance or information (transfer and consulting activities) is probably not sufficient. It seems important and necessary to integrate a regional innovation policy more with the long run structural improvement of the regional economies. The latter implies more selectivity and a change in the regional investment promotion: both the subsidization of new plants as well as the expansion of existing plants should be linked much more to structural criteria (e.g. level of skill, functions performed, potential linkages to regional firms). The promotion of investment should also be related more to "immaterial investment" (human capital, organisational improvement, functions outside production) than in the past. It also implies an improvement of locational conditions such as the qualifications of the labor force, the access to producer services and information centers (transfer agencies, research centers) and the availability of innovation relevant infrastructure (telecommunication, rapid transport) in those regions.
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LIST OF VARIABLES IN THE PROBIT-MODELS OF FIG. 3 TO 5:

DEPENDENT VARIABLES: (binary variables)

product innovation "new to the market": plant has introduced from 1981 to 1986 one or more product innovations considered as "new to the market"

introduction of CNC: plant has introduced CNC-technology

introduction of CAD: plant has introduced CAD-technology

EXPLANATORY VARIABLES:

location in Obersteiermark: dummy variable for location of the plant in the case-study area of Obersteiermark

endogenous plant: dummy variable for lack of organisational or ownership links of the plant to extraregional firm(s)

branch plant: dummy variable for plant with extraregional headquarter

electrotechnical industry: dummy variable for plant belonging to electrotechnical or electronics industry

% export: percentage of exported sales

technological advantage: dummy variable for indication of the plant of a competitive advantage via "technology"

innovation promotion: dummy variable for plant having received financial support from public innovation policy

size of plant: number of employees of the plant

profit situation: dummy variable for indication of the plant of "good to high profits" for past 5 years

R&D: percent of employment concerned with R&D activities (full time equivalents)

marketing: dummy variable for indication of plant of full performance of marketing activities

% higher level commercial employment: percentage of employees with medium to high level commercial education

% white collar: percentage of other white collar employees

% unit production: percent turnover of unit production

% mass production: percent turnover of mass production

% products less 10 years: percent turnover of products which are more than 10 years in the production program of plant

financial obstacles: dummy variable for indication of financial obstacles in the innovation process

lack of technicians: dummy variable for indication of problems with regard to the availability of technical personnel in the innovation process
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