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The regional variation of new technology based firms in Austria

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The regional variation of new technology-based firms in Austria

Preliminary results of an empirical study

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Abstract

During the last two decades the role of new firms has gained a growing interest both from regional economics as well as from (regional) economic policy. It was recognised that not only the large Galbraithian enterprise is the driving force in processes like employment growth or structural economic change, but also small and often new or young firms are playing an active role. In the 1980s so called new technology-based firms (NTBFs) gained considerable attention. It has been argued that the Schumpeterian entrepreneur is an important force for the implementation of new ideas into the market place, often via the formation of NTBFs.

In our paper we analyse the structure and the regional variation of new firm formation in the high technology sector in Austria. Using a definition based upon the OECD we differentiate the high tech sector in (i) top technology, (ii) higher technologies and (iii) technology orientated services. We demonstrate the relative importance of these groups for the total population of new firms in Austria in the time period between 1990-1994 as well as for certain sub-populations like manufacturing and services.

The main part of our paper discusses the regional variation of NTBFs using the framework of the well known urban incubator hypothesis. It is expected that metropolitan and urban regions have a higher orientation towards high tech (what means the proportion of NTBFs) than the rural or hinterland regions. An additional part of our paper deals with the question whether NTBFs play an important role in the process of structural change of regional economies as has been postulated by various authors during the last couple of years.

1. Introduction

During the last two decades the role of new firm formation has gained a growing interest both from regional economics as well as from (regional) economic policy. It was more and more recognised that not only the large Galbraithian enterprise is the driving force in processes like employment growth or structural economic change, but also small and often new or young firms are playing an active role in these processes. There is now widespread agreement that new firms play a crucial role, at least up to a certain amount, in following areas:

- Almost by definition they guarantee the openness of a specific market and thus they help to *”provide an equilibrating function in the market, in that the levels of price and profit are restored to the competitive levels”* (Audretsch 1995, 39, see also Mueller 1990).
- They provide new job opportunities and thus they are an important source of employment growth. Especially the study by Birch (1979, 1981), which attributed about 60 % of net job generation in the United States to new and/or small firms prompted numerous further research. Despite some researchers questioned this high importance for net job generation (cf. Semlinger 1995, Davis et al. 1996) the positive impact of new firm formation on employment creation is now widespread acknowledged (Egeln et al. 1998). However, the role of new firms (and especially NTBFs) in creating new employment and contributing to the solution of unemployment should not be exaggerated (Licht and Nerlinger 1998, 1006).
- They may play an active role for the structural change of an (regional) economy and thus they may accelerate the ongoing transition process from secondary activities to tertiary and quaternary activities. Numerous studies show that the major bulk of new firms belong to the service sector (see for example Garofoli 1994), reflecting also the much lower barriers to entry in this sector in comparison with manufacturing.
- They are themselves an important source of innovation and thus they are accelerating the pace of technological change (Rothwell and Zegveld 1985, Acs and Audretsch 1990). New firms fulfil this accelerating role in two ways, directly through developing new products, production techniques and services, and indirectly, insofar as they force existing firms to react to this competitive pressure of the new entrants.

The latter two aspects – the role of new firms for structural and technological change - are in the centre of our analysis. The structure of our paper is as follows: In chapter 2 we give a short discussion about the importance of NTBFs in the process of technological change as well as a short review why a regional variation in new high-tech firm formation is to be expected. Additionally, we explain our definition of NTBFs and give an overview of our data-base of Austrian NTBFs which have been founded during the time period between 1990 and 1994.

In chapter 3 we analyse the regional variation of new firm formation in the high technology sector in Austria. We demonstrate the relative importance of NTBFs for the total population of new firms in Austria as well as for certain sub-populations like manufacturing and services. The main part of this chapter discusses the regional variation of NTBFs using the framework of the well known urban incubator hypothesis. It is expected that metropolitan and urban regions have a higher specialisation towards high tech in new firm formation, that means their NTBF's share of all new firms is disproportionately large in urban areas relative to rural or hinterland regions. An additional part of this chapter deals with the question whether NTBFs play an important role in the process of structural change of regional economies as has been postulated by various authors during the last couple of years. The paper closes with a short summary of the main findings (chapter 4).

2. The role of new technology based firms in the process of technological change and regional development

2.1 New technology-based firms and the innovation process

The contribution of new and small firms to the process of technological change is a matter of a long debate (see e.g. Rothwell and Dodgson 1994). Traditionally, this debate has been centred on the question, whether large or small firms are the most frequent and efficient innovators and whether the large firm operating in a concentrated market is the main engine of technological change or the small and flexible one which keeps abreast with fast changing market requirements. The vast amount of empirical studies on the relationship between firm size and innovation are surveyed in very detail by Cohen and Levin (1989) and Cohen (1995). The well known SPRU-Database on about 4000 innovations in the U.K., which have been introduced to the market-place in the time period between 1945 and 1983 reveals that the share of national innovations introduced by smaller firms (1-199 employees) has been

increased considerably with time. This share was growing constantly from a minimum of 13,6 % between 1960 and 1964 up to 26,3 % during 1980 and 1983, the last time period for which data are available. Further analysis of the SPRU-Database provided evidence that small firms had a larger share of innovations than that implied by their respective share of employment. This implies that in the early 1980ies small firms had become a disproportionately important source of innovation (Pavitt et al. 1987). However, it has to be mentioned that a recent re-examination of a revised version of the SPRU-Database yields that smaller firms had been a less important source of technological innovation. The results based upon the revised version give evidence that the share of innovations is not disproportionately large relative to their share of employment (Tether et al., 1997).

Recently the emphasis has partly shifted to the analysis of interactions and complementarities between small and large firms (Rothwell and Dodgson 1994) and it is now widespread acknowledged "... *that both large and small firms play important, if different, roles in innovation*" (Tether et al. 1997, 20). According to Rothwell and Dodgson (1994, 310) the advantages of new technology-based firms are mainly behavioural advantages like their entrepreneurial dynamism, their internal flexibility and responsiveness which makes them possible to keep abreast with fast changing market requirements. Important disadvantages for young firms are to be found in the sphere of the general accessibility of resources. New firms lack an easy access to financial as well as technological resources (see Table 1), hence they do have "material" disadvantages in the innovation process.

Table 1: Advantages and disadvantages of new technology-based firms in the innovation process

| | advantages | disadvantages |
|--------------------|---|---|
| Management | Little or no bureaucracy, entrepreneurship, rapid decision making, risk-taking | often no formal management skills |
| communication | fast and effective internal communication; informal networks | Lack of time and resources to build up external R&D networks |
| Marketing | Fast reaction to changing market requirements; possibility to dominate narrow market niches | Lack of resources, market start-up can be prohibitively costly |
| Technical Manpower | Founder is the promotor of his/her own idea | Problems in hiring employees with high-level technical skills ; Full-time R&D can be prohibitively costly |
| finance | | Access to external capital difficult; no possibility to spread risks, cost of capital can be higher |

| | advantages | disadvantages |
|---------------------------|---|--|
| growth | growth through niche strategy | Problems in accessing external capital for growth, founder has often no desire to growth |
| regulation | | Entry barriers through regulation; problems assessing the legislative framework |
| Government schemes | Specific schemes to stimulate innovation and (high-tech) start-ups | lack of awareness, difficulties in coping with collaborative schemes |
| Learning ability | 'Learning by doing'; 'Learning by using', no 'unlearning' problems | |
| Organisation | Simple and focused, organic | |
| Joint venture/Alliances | If technological very sophisticated attractive as a partner for large firms; possibility of sponsored spin-off, contract our R&D etc. | Little experience; power imbalance |
| Relationship to suppliers | | No or only little control over suppliers |

Source: adapted from Rothwell and Dodgson 1994, 311

Of course considerable sectoral differences in the contribution of NTBFs to innovation and technological change can be observed. In some sectors entry barriers are very high or maybe – except for some small market niches – almost prohibitively. In sectors with high capital requirements, significant internal economies of scale and/or high orientation towards formalised large-scale R&D structures the contribution of NTBFs is general low. These sectors include for example shipbuilding, aerospace, dyes, pharmaceutical, motor vehicles, iron and steel etc. (Rothwell and Dodgson 1994). In other sectors, like especially specialist machinery, instruments and measuring devices etc. the contribution of NTBFs to the sectoral technological development can be very significant. In general, where entry costs are low, NTBFs can play an important role and vice versa.

The importance of NTBFs for technological change does not only vary among sectors. It does vary over the stages of the product cycle, also: *"... entrants are often important in the early evolution of a market because they provide the grist from which the mill of selection eventually produces a product (or product range) valued by consumers. ... However, at some point in the development of a new market, consumer preferences become reasonably well formed and coalesce around a small subset of products (or a 'dominant design') containing a particular range of attributes. At this stages of industry development, competitive rivalry often shifts from competition between competing product designs to competition based on prices and costs to supply a particular design. Early movers rush to exploit economies of scale and*

trundle down the learning curve; distribution systems are set up, and marketing campaigns try to create brand loyalty and lock in buyers in a variety of ways. New entrants are often at a severe disadvantage in this type of competitive process (which tends to create high product differentiation advantage, and, as a consequence, their role in shaping industry structure and affecting industry performance is much diminished.” (Geroski 1995, 437). Rothwell and Dodgson (1994) refer to dynamic complementarities existing between large and small/young firms especially in the first stages of the product cycle or even in creating or developing genuinely new high-tech sectors of industry. In this case, large firms often employ NTBFs as a source of technology (or general as idea-generators) via joint ventures and/or various other modes of interaction (for example licensing, subcontracting, contract-out R&D, sponsored spin-offs etc.).

2.2 Regional variations of new technology-based firm formation – some theoretical considerations

As many empirical studies show, the regional distribution of new technology-based firm formation is very uneven. At a first glance this is not very surprising given the huge differences in size and economic potential of different regions. What is much more impressive is that the relative importance of NTBFs in the general process of new firm formation varies considerably from region to region (see for example Licht and Nerlinger 1998). One important question studying this regional variation of high-tech firm formation which attracted a growing interest during the last years, is whether there is some sort of spatial clustering or localisation. As it was shown in a number of studies such clustering tendencies can be found frequently in the United states as well as (perhaps less frequently) in Europe, with the famous examples of some "high-tech" clusters like Silicon Valley or the "Route 128" area surrounding Boston/Mass or the M4 corridor and Silicon Glen in Europe (see among many others Markusen et al. 1986, Scott 1988, Storper 1992). The forces behind clustering are expected to be increasing returns external to the firm but internal to the region (so called Marshallian externalities). According to Krugman (1991) it is possible to distinguish between three types of sources for increasing returns at a regional level:

- A pooled labour market with the emergence of technology-specific skills,
- pecuniary externalities through the availability of (specialised) nontraded inputs,
- technological or knowledge spillovers.

The arguments for regional clustering go back to A. Marshall (1920): *"Employers are apt to resort to any place where they are likely to find a good choice of workers with the special skill which they require; while men seeking employment naturally go to places where there are many employers who need such skills as theirs and where therefore it is likely to find a good market. When industry has chosen a locality for itself, it is likely to stay there long; so great are the advantages which people following the same skilled trade get from their near neighbourhood to one another. The mysteries of the trade become no mysteries; but are as it were in the air, and children learn many of them unconsciously. Good work is appreciated, inventions and improvements in machinery, in processes and the general organisation of the business have their merits promptly discussed; if one man starts a new idea, it is taken up by other and combined with suggestions of their own; and thus it becomes the source of further ideas. And presently subsidiary trades grow up in the neighbourhood, supplying it with implements and materials, organising its traffic, and in many ways conducing to the economy of its material."*

It has been argued that these gains from clustering are especially significant in high tech industries, due to the significant importance of knowledge- and information-rich activities. Indeed, this observation is acknowledged by leading businessmen: *"Our industry tends to cluster geographically. Why? Because it is to take advantage of the infrastructure of talent pools, support services, venture capital, and suppliers"* (Noyce 1982, 14, quoted after Malecki 1991, 222). Thus it can be argued, that high-tech firms which are located in regional clusters can profit extensively from the specialised labour market and especially from knowledge and/or technological spillovers between the firms. The dense information networks which characterise such clusters facilitate the transfer of tacit knowledge (Dosi 1988) which is argued to be among the crucial factors enhancing the innovative capacity of a region. Indeed, for example, Hill and Naroff (1984) found that high tech firms located in a region with an existing concentration of high tech firms experienced higher returns and lower risks. Other empirical evidence concerning the positive impact of clustering are presented among many others by Bernstein and Nadiri (1988), Feldman (1994) or Audretsch and Feldman (1994).

The second important question concerning the geographical distribution of new high-tech firm formation is whether a centre-periphery pattern can be observed or not. According to the well known urban incubator hypothesis (see Davelaar and Nijkamp 1987, Davelaar 1989) it could be expected that urban regions are the main seedbeds for new firms, especially in the high tech

sector, since they are the prime location of important innovation-relevant factors and hence offer certain locational advantages to potential new founders. Of course this is strongly related to the question of clustering since regional clusters often are themselves a certain type of agglomeration. However, a distinction should be made because the urban incubator hypothesis asks if the existing centre-periphery structure has explanatory power for the regional variation of high-tech firm formation whereas new regional clusters can occur (and perhaps regularly occur) outside the existing urban pattern (Storper and Walker 1989).

2.3 Definition of NTBFs and Data sources

Despite the growing interest on NTBFs there is no clear-cut definition of what is meant by the term "New Technology-Based Firm", but there are very different opinions and different definitions, depending often on the availability of data. The famous study conducted by the Arthur D. Little Group (1977) defined a NTBF as an independently owned firm not older than 25 years and whose main aim is to exploit a technological invention or innovation. Other authors apply the word "new" to the technology used, or to both, the technology and the firm (see for a discussion of different definitions Storey and Tether 1998). In our paper we decided to use a definition based upon two different concepts. To be coined as a NTBF, the firm must satisfy following two criteria:

- (i) the firm has to be an independent enterprise which is genuinely new at the marketplace (founded between January 1st, 1990 and December 31st, 1994, and
- (ii) the firm has to operate in "high technology" sectors (for a definition of "high technology" see below).

The data on new firms originate from a credit rating agency named CREDITREFORM, one of Austria's largest in this business field, and have been compiled in close collaboration with the Centre for European Economic Research (*Zentrum für Europäische Wirtschaftsforschung, ZEW*) in Mannheim/FRG (Egeln et al. 1998). The data encompass all new firms which are compelled to file information with the commercial register (*Handelsregister*). Such a registration is compelled for practically all firms with the exception of small single professionals in the service sector. The time period we analyse span from January 1st, 1990 to December 31st, 1994. The total number of new firms (from all economic sectors excluding agriculture) is about 58.000. One drawback is that we have information on product groups for only approximately 29.000 firms. Hence our absolute numbers are severely underestimated.

However, since we concentrate our analysis on relative comparisons rather than on absolute numbers of new high-tech firms, this underestimation does not influence significantly the validity of our results.

To identify technology-based firms we used a top down "high technology" definition proposed by the OECD (see Nerlinger and Berger 1995). This classification is based on the average R&D intensity of five-digit industry groups (so called WZ79). If the R&D intensity (R&D expenditures in percent of turnover) of a five-digit group is 8,5 % or more, we classify this group as top technology, with a R&D intensity in the range from 3,5 to 8,5 % we classify it as high technology. Five-digit groups with a R&D intensity below 3,5 % are classified as low and medium technology (see table 2). Of course, such an industry specific definition of "high technology" has several drawbacks. Once industries or product groups are categorised as "high tech", every firm operating in such industries are considered as being a high tech firm, independent of whether the firm is really innovative or not. A second disadvantage associated with such a definition is the fact, that there surely are firms which are very innovative and perhaps on the technological forefront which are not considered as high tech, simply because they do not belong to the top down defined high tech industries. However, due to data constraints and availability, we are forced to choose this commonly used high tech definition.

Table 2: Classification of High-Tech-Fields in manufacturing

| WZ 79 Codes | Industry group |
|-------------|---|
| | Top Technology Industries |
| 20100 | Synthetic Rubber and Plastics |
| 248 | Aircraft and Spacecraft |
| 2506 | Communication Equipment and Electronic Components and Assembly |
| 25211 | Optical Instruments (without Optical Equipment and Cinematographic Equipment) |
| 25270 | Medical, Dental and Orthopaedic equipment |
| 20031 | Drugs, Pharmaceuticals |
| 24350 | Computers and Computer Equipment |
| | High Technology Industries |
| 24210 | Manufacture of Metal Working Machinery |
| 24240 | Manufacture of Machineries for Food and Beverage, Chemical Industry and Similar Machineries |
| 24421 | Manufacture of Machinery for Mining and Earth Moving Equipment |
| 24225 | Manufacture of Machinery for Construction |
| 24280 | Manufacture of Bearings, Gears, Gearing and driving Elements |
| 2427 | Manufacture of Special Industry Machinery |
| 24290 | Manufacture of Machinery not elsewhere classified |
| 24410 | Manufacture of Motor Vehicles and their engines |
| 25010 | Manufacture of Batteries and Accumulators |
| 2503 | Manufacture of Machinery and Equipment for Generation and Distribution of Electricity |
| 2504 | Manufacture of Lighting Equipment and Electric Lamps |
| 25050 | Manufacture of Household Appliance |

| WZ 79 Codes | Industry group |
|-------------|--|
| 25071 | Manufacture of Radio, Television and Phono Apparatus and Equipment |
| 25215 | Optical Equipment |
| 25220 | Manufacture of Photographic and Cinematographic Equipment |
| 2525 | Precision Engineering |
| 20010 | Manufacture of Basic Chemicals |
| 2002 | Manufacture of Agro-Chemical Products and Industrial Chemicals |
| 20035 | Manufacture of Photochemical Products |
| 20040 | Manufacture of Chemical Fibres |
| 24310 | Manufacture of Office Machines |

Source: Nerlinger and Berger, 1995

The increasing importance of the service sector with regard to innovation and technological change is being recognised more and more. Indeed, some services are at the forefront of innovation: *"... new IT-based services, such as software and telematics, are triggers to innovation across the economy, rather than passive recipients of innovation from the manufacturing industry."* (Miles 1994, 252). Thus, especially the emergence of an autonomous software sector with tight links to the computer industry and the recognition of constantly growing R&D expenditures by the service sector make it necessary to integrate the service sector into the definition of technology intensive sectors (Malecki 1991, Nerlinger and Berger 1995). Under the heading of "technology intensive services" we understand services with a high complexity and/or knowledge intensity. Table 3 shows our classification of technology-intensive service sectors.

Table 3: Classification of technology-intensive service sector

| WZ 79 Codes | Technology Intensive Service Sectors |
|--------------|--|
| 75110 | Higher Education Institutes and Laboratories |
| 75130, 75140 | Research and Development in Natural Sciences and Engineering |
| 784 | Professional and Technical Services not elsewhere classified |
| 78920 | Computer Services |

Source: Nerlinger and Berger, 1995

3. The structure and regional variation of NTBFs in Austria

3.1 Regional variation of new high tech firm formation

It is a almost trivial fact that the major bulk of NTBFs will be founded in and around urban areas, since the absolute number of potential founders is of course greater in these areas than in the rural and/or peripheral hinterland. In Austria, metropolitan regions account for about

three quarters of NTBFs which have been founded between 1990 and 1994. Figure 1 shows the regional distribution of NTBFs at the district level. Figure 1 reveals that Vienna and the urban cores, especially *Graz*, *Linz*, *Salzburg* and the districts in the rhine valley (*Vorarlberg*) emerge as particular frequent locations for new high-tech firms. Additionally, the *Untereinntal* in the Tyrol and the west-east corridor between *Salzburg* and *Linz*, as well as the suburban region south to Vienna are important seed-beds for new high tech firms.

Figure 1: Regional distribution of new technology based firms in Austria (1990-1994)



Note: 1 dot represents 1 new high tech firm, the spatial distribution of dots within a political district is arbitrary

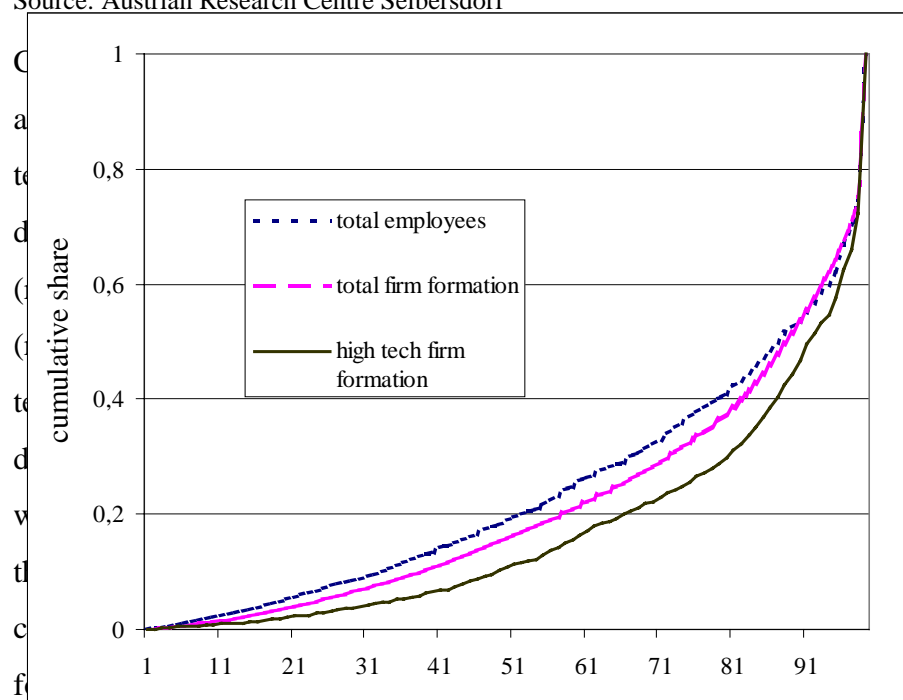
Source: Austrian Research Centre Seibersdorf, ZEW Mannheim

What is quite more interesting is, whether there is a concentration of NTBFs in respect to some control variables or not. In figure 2 we therefore plot concentration curves based upon the 99 political districts of Austria for NTBFs in comparison with the respective curves for total new firm formation as well as for total employees (year 1991). Figure 2 yields that there is at least some amount of relative regional concentration of high tech firm formation as is indicated by the position of the NTBF curve below the concentration curves of total firm formation and total employees. It can be calculated from figure 1 that for instance the "first" 10 districts in respect to high tech firm formation (including major cities like Vienna, *Graz*, *Linz*, *Salzburg* and *Innsbruck* as well as some dynamic suburban rings like *Mödling*, *Linz-*

Land or Innsbruck-Land) account for 55 % of all NTBFs while their share of total firm formation is just about 45 %.

Figure 2: Regional Concentration of Firm Formation in Austria

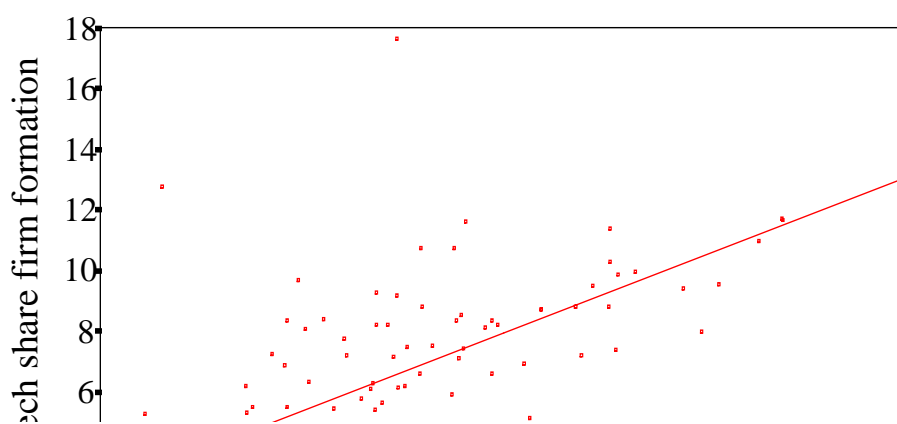
Source: Austrian Research Centre Seibersdorf



regions where there is a high tech sector, high-technology oriented districts are disproportionately large. Figure 3 shows a positive relationship of high significance between the share of high-tech firms in a region and the rate of high-tech firm formation. Once a region becomes high-tech oriented, it is reinforced through high-tech firm formation at the district level (see Figure 2 for the distribution of employment in 1991). The partial correlation coefficient of $r = 0,45$, $p < 0,001$ indicates that the partial correlation between the share of new firm formation and the share of high-tech firms is 0,49 which is a little

bit lower in absolute terms than the simple r , however it is significant at the 0,001 level as well. This demonstrates that, even after controlling for size, new firm formation in already high-technology oriented districts is characterised by a disproportionately large NTBF share. This positive relationship gives some empirical evidence of clustering at the district level in Austria. Districts which are already specialised in High Tech attract relatively more new High Tech firms.

Figure 3: Relationship between share of high-tech sector of already existing firms and new firms



-based firms in Austria
Helmut Gassler

3.2 Structural differences between regions in NTBF formation

According to the urban incubator hypothesis it could be expected that new firm formation in urban regions is relatively more specialised towards the high tech sector than in rural/peripheral regions. To test for this hypothesis we classify the 99 political districts (so called "Bezirke") of Austria into four different regional types or groupings, each of them having a different position in the centre-periphery hierarchy, with Vienna at the top and the rural/peripheral areas at the bottom line:

- Vienna
- Urban Cores
- Suburban region
- Rural/peripheral Areas.

Vienna, as Austria's primate city, is the most popular location for headquarters of government and business, as well as for centralised research and development units of industry, government and other public or semi-public agencies, and has a concentration of high-quality universities with advanced research laboratories and departments from which entrepreneurs might obtain valuable technological advice and assistance. All these institutions form a huge potential for technology-based spin offs. Located in Vienna are information-intensive activities in consultancy, libraries, information centres, financial institutes, etc. The region is information rich and characterised by a relatively high level stock of knowledge enlarged through R&D of products, processes and techniques in science, technology and business organisation, as well as through nutrient information flow via social and professional networks within the academic, technological, business/management, financial and entrepreneurial sphere. The structural composition of employment is based mainly upon the tertiary and quaternary sector while manufacturing is declining constantly since the early 70ies.

Urban cores – including for example, *Graz, Linz, Innsbruck, Salzburg, Klagenfurt, Villach* – are in the second line of the Austrian urban hierarchy. They can be characterised by a relatively high entrepreneurial vitality with characteristics similar to Vienna, of course on a much lower scale. Most of them are locations for institutions, such as universities (or at least colleges of higher education so called *Fachhochschulen*) with diverse research institutes, institutes of technology transfer, consultancies or other suppliers of information. The

employment structure is similar to Vienna, growing employment in the service sector is confronted by a declining manufacturing base.

Suburban regions surround Vienna or Urban Cores and are currently the most dynamic regions in terms of population growth (through immigration) as well as employment growth (both through relocation from the urban core as well as through growth of the indigenous industry). Employment growth rates have been particularly high in producer services during the last decade (Hesina et al. 1996, Tödting and Traxler 1995). Suburban regions have high and continuously growing links to their urban cores especially in terms of commuting. Together with their respective urban cores they form metropolitan areas as functional units. Due to the nearness to their urban cores and their access to high-ways the accessibility of suburban regions is general high. It can be expected that suburban regions benefit mostly from agglomeration economies generated by their urban cores without suffering from potential agglomeration diseconomies (congestion, land shortages, high land costs).

Rural/Peripheral regions are characterised by a low population density and just a few small towns or cities (so called "*Bezirkshauptstädte*") with a maximum population size of about 10.000 to 30.000 or even smaller. They tend to have a high concentration of small firms (both branch plants and independent enterprises). There is a slow uptake of the best practice and a general low level of technology of the indigenous regional manufacturing sector, which remains more or less unaffected by the higher technological standard of multiregional plants. The remoteness, and hence low accessibility of most rural regions also inhibits the fast diffusion of technology. Entrepreneurs in these regions have poorer access to informal networks and information flows. However, some districts of this regional type have experienced a significant regional modernisation process during the last decades. This holds true especially for districts which have access to major highways or railroads (like for instance *Amstetten*, *Tulln* (Lower Austria), *Gmunden*, *Vöcklabruck* (Upper Austria), the districts in the *Untereinntal*/Tyrol etc.).

One drawback associated with our regional grouping of districts has to be mentioned. Like in many other developed countries there exists a specific regional type which is not explicitly covered by our classification, namely old industrialised regions. In Austria, usually the *Obersteiermark* (districts *Bruck/Mur*, *Leoben*, *Mürzzuschlag*) and some districts in other federal states like *Neunkirchen* (Lower Austria) or *Braunau* (Upper Austria) are characterised

as old industrialised regions (Palme 1989). Due to their small number they are subsumed as rural/peripheral areas in our regional classification.

The share of technology intensive firms from the manufacturing industry in percent of all new firms is generally very low in Austria, as can be seen from Table 4. New top-tech and high tech firms together account for only 1,95 %. The share of new technology intensive service firms of total firm formation is much higher (average for Austria 6,73 %). This demonstrates once more that it is necessary to include technological and/or knowledge intensive services into studies concerning NTBFs. At a first glance the results of Table 4 seem to be contradictory to the expectations of the urban incubator hypothesis. Vienna, for example, Austria's primate city with outstanding locational factors in relation to innovation (see the discussion of the regional types above) has the lowest share of NTBFs from the manufacturing sector of all regional types. And the urban cores, too, do not have a disproportionately large share of new manufacturing high tech firms. The highest share of manufacturing NTBFs (both top-tech as well as high-tech) can be found in suburban regions followed by rural/peripheral regions. Only in respect to technological services, a clear centre-periphery hierarchy can be obtained, with the urban cores and Vienna as leading regions (share 8,82 % and 8,21 % respectively) followed by the suburban regions (6,59 %) and the rural/peripheral areas, with a share of only 4,86 %.

Table 4: New technology-based firms over different regional types (percentage of total new firms in the respective regional type)

| Regional type | Top-Tech | High-Tech | Top plus High-Tech | Techn. services |
|------------------------|----------|-----------|--------------------|-----------------|
| Vienna | 0,63 | 0,84 | 1,47 | 8,21 |
| Urban Cores | 0,63 | 1,25 | 1,88 | 8,82 |
| Suburban Regions | 0,83 | 1,55 | 2,38 | 6,49 |
| Rural/peripheral Areas | 0,68 | 1,42 | 2,10 | 4,86 |
| Austria | 0,68 | 1,27 | 1,95 | 6,73 |

Source: Austrian Research Centre Seibersdorf, ZEW/Mannheim

However, it can be shown that the low shares of NTBFs from the manufacturing sector in urban regions are a result of the overall structure of firm formation in these regions (see Table 5). In Vienna, as well as in urban cores, the overwhelming majority of new firms are from the tertiary sector. Only 7 % of all new firms in Vienna belong to the manufacturing sector while the respective share in rural/peripheral regions is about 17 %. Since the share of

manufacturing is much lower in urban areas than in rural/peripheral areas and since new Top-Tech and High-Tech firms belong to the manufacturing sector, their share of total firm formation "must" be ceteris paribus lower, also.

Table 5: General Structure of Firm Formation 1990-1994 by regional types (share in percent)

| Regional type | Manufacturing | Construction | Retailing | Traffic | Services | Other | Total |
|------------------------|---------------|--------------|-----------|---------|----------|-------|-------|
| Vienna | 7,0 | 12,6 | 40,5 | 5,2 | 34,3 | 0,4 | 100 |
| Urban Cores | 10,4 | 8,6 | 36,2 | 4,8 | 39,3 | 0,7 | 100 |
| Suburban Regions | 12,6 | 13,9 | 39,5 | 5,3 | 28,2 | 0,5 | 100 |
| Rural/peripheral Areas | 16,6 | 16,1 | 34,9 | 5,1 | 26,3 | 1,0 | 100 |
| Austria | 11,5 | 12,9 | 37,7 | 5,1 | 32,2 | 0,7 | 100 |

Source: Austrian Research Centre, ZEW/Mannheim

Thus, to control for this structural effect, we calculated the share of new top-tech and high-tech firms in the manufacturing sector and the share of new technology intensive service firms in the service sector, respectively (table 6). Table 6 provides evidence that there is indeed a clear centre-periphery pattern as it is expected by the urban incubator hypothesis. New manufacturing firms in Vienna and other urban regions are much more likely to belong to high technology industries than in rural/peripheral areas. In Vienna NTBFs account for about 21 % of all new manufacturing firms while only 13 % in the rural/peripheral areas belong to high tech. The difference in the shares of NTBFs is especially impressive in the case of top-tech. About 9 % of all new manufacturing firms in Vienna are classified as top-tech, while in rural/peripheral areas the respective share of top-tech is only 3,89 %. A similar, but less pronounced pattern can be found with respect to technological services. Again, Vienna has with almost 25 % the highest share while in rural/peripheral areas just about 17 % of new service firms can be characterised as technology intensive.

Table 6: Share of NTBFs in the manufacturing sector and in the service sector (1990-1994) in %

| Regional type | With respect to manufacturing | | | With respect to services |
|------------------|-------------------------------|-----------|--------------------|--------------------------|
| | Top-Tech | High-Tech | Top plus High-Tech | Techn Services |
| Vienna | 8,96 | 11,95 | 20,91 | 24,46 |
| Urban Cores | 7,40 | 12,60 | 20,00 | 21,06 |
| Suburban Regions | 6,44 | 12,28 | 18,72 | 22,60 |
| Rural Areas | 3,89 | 9,30 | 13,19 | 17,09 |
| Austria | 5,96 | 11,04 | 17,00 | 20,90 |

Source: Austrian Research Centre, ZEW/Mannheim

3.3 NTBF formation and regional structural change

To identify the extent to which new high-tech firms contribute to structural change at the regional level we compare the structural composition of new firm formation (share of NTBFs of all new firms) with the structural composition of the already existing stock of firms (high-tech Share of all existing firms). To do this, we calculate a simple "structural change index" which has the following formal definition:

$$SQ_i = \frac{\frac{NTBF_i}{\sum NF_i}}{\frac{ETBF_i}{\sum EF_i}}$$

where SQ_i denotes the "structural change index" of region i , $NTBF_i$ the number of new technology based firms in region i , $\sum NF_i$ the total number of new firms in i , $ETBF_i$ the number of already existing technology based firms in i (year of founding before 1990) and $\sum EF_i$ the total number of all firms in i with a founding year prior 1990. Table 7 demonstrates that in all regional types (with the notable exception of high-tech in Vienna) $SQ_i > 1$. This demonstrates that the share of technology intensive firms is higher concerning new firm formation as it is concerning the stock of already existing firms. What is worth mentioning is that table 7 provides evidence that there is a reversed centre-periphery pattern. The "structural change index" is general higher in rural/peripheral areas than in urban areas. Of course, this pattern results from the very low technology orientation of already existing firms in rural/peripheral regions so that the denominator (share of existing high tech firms) is very small. For example, in rural/peripheral areas the share of high tech firms of already existing manufacturing firms is just 7,5 % while in Vienna it is about 21 % However, the structural change induced by NTBFs seems to be relatively stronger in rural/peripheral areas. This gives evidence that NTBFs induce a significant modernisation process which is especially pronounced in rural/peripheral areas.

Table 7: Structural change through high-tech firm formation – "Structural change index" by regional type and technology sector

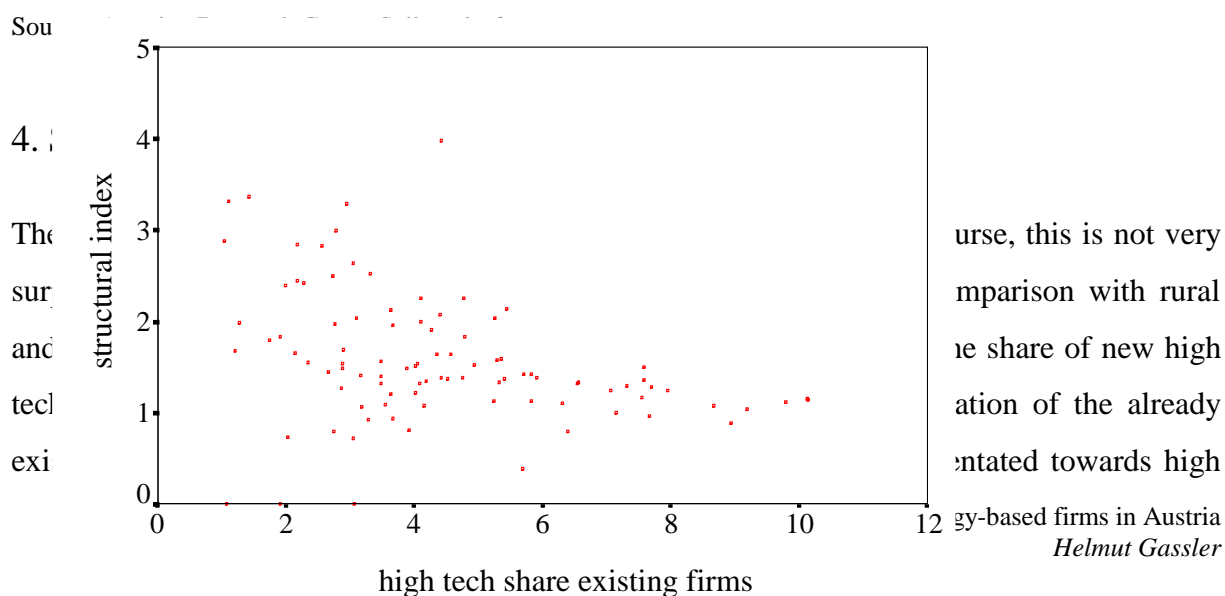
| Regional type | With respect to manufacturing | | | With respect to services |
|---------------|-------------------------------|-----------|--------------------|--------------------------|
| | Top-Tech | High-Tech | Top plus High-Tech | techn. services |

| | | | | |
|------------------|------|------|------|------|
| Vienna | 1,1 | 1,0 | 1,0 | 1,3 |
| Urban Cores | 1,5 | 1,3 | 1,4 | 1,1 |
| Suburban Regions | 1,8 | 1,2 | 1,4 | 1,4 |
| Rural Areas | 2,0 | 1,7 | 1,8 | 1,7 |
| Austria | 1,52 | 1,30 | 1,37 | 1,33 |

Source: Austrian Research Centre Seibersdorf, ZEW/Mannheim

Figure 4 demonstrates the relationship between high-tech orientation of existing firms and that of new firms at the level of Austrian districts. Of course this relationship is by no means perfect. However, the results of correlation analysis indicate that there is indeed a significant inverse relationship ($r = -0,39$, $p < 0,001$). Again we control for district size by calculating the partial correlation coefficient because there is a slight negative correlation between district size and structural index ($r = -0,20$, $p < 0,05$). Controlling for district size, the partial correlation coefficient between high-tech share of existing firms and structural change index is $-0,35$ ($p < 0,001$). Thus, independently of district size, the lower the level of technology-orientation of the existing economic base of a district, the relatively sharper a district is confronted to structural change through new high-tech firm formation.

Figure 4: Regional Structural change at the district level through NTBFs in Austria



tech industries (including the service sector) the NTBF's contribution to new firm formation is general higher. This can be interpreted as a clustering process. New high tech firms are founded in districts where there are already relatively many high tech firms. A partial correlation analysis demonstrates that this relationship holds true even after controlling for district size.

New high tech firms in the manufacturing sector do have only a tiny share of overall firm formation in Austria. Only approximately 2 % of all new firms are to be characterised as manufacturing firms operating in the high tech sector. If the manufacturing sector alone is considered new high tech firms account for about 17 % of all new manufacturing firms. This share varies considerable between regions. A clear urban-periphery pattern can be observed. In urban regions as well as in suburban regions the share of new high tech firms in the manufacturing sector is significantly larger than in rural and/or peripheral areas.

The importance of new high tech service firms is much greater, their share of overall firm formation is about 7 %; their share of firm formation in the service sector alone is about 21 %. Again a significant, but less pronounced centre-periphery pattern can be obtained. The importance of new high tech service firms in the firm formation process confirms once more the necessity to include the service sector in studies concerning technological change

In respect to the contribution of new high tech firm to structural change at the regional level, a somewhat revised centre-periphery pattern has been obtained. The NTBF's share of new firm formation in rural/peripheral regions in comparison with their TBF's share of the existing firms is relatively larger than in urban areas. Of course the specialisation of already existing firms towards the high tech sector is much lower than in urban areas. Nevertheless NTBFs induce a modernisation process which is relatively more pronounced in areas at the bottom line of the centre-periphery hierarchy.

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