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Newly Established Polytechnics And Their Contribution To Regional Development

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Newly Established Polytechnics and their Contribution to Regional Development

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Regional Science Association 40th European Congress, Barcelona, Aug. 29th – Sep. 1st, 2000

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Abstract

Since 1994 the range of knowledge infrastructure institutions in Austria has been enlarged by establishing polytechnics as universities of applied sciences in different regions of the country. On the one hand this was done to fill in a gap in the education system, because polytechnics operate in the nexus between universities and technical or economic colleges. They teach on a more advanced level than the colleges, but in a more applied form than universities. On the other hand they were created to support the regional economy, because they offer more applied research and are interested in the day to day problems of the SMEs. As a part of the knowledge infrastructure in an innovation system polytechnics therefore contribute to a learning economy and foster economic growth.

This paper will in a first step examine the links between learning, innovation and regional development and have a closer look on the important role which polytechnics have in this context, especially in supporting innovation and development in SMEs. In a second step an innovative organisational form of a polytechnic, a dual system, where periods of studying alternate with periods of working experience, will be presented. Finally the paper will discuss the possible effects of this new system on innovation and regional development.

Key words: knowledge infrastructure, learning, innovation, regional development.

1. Introduction

Since their launch in autumn 1994 the number of Austrian polytechnics has grown continuously. Starting with 10 different courses they now ran more than 60, offering a wide range of university level education and training with a mix of technical and economic emphasis (Strobl and Birke 1999). The polytechnics are situated in different parts of the country with a slight tendency of concentration in urban areas.

Unlike universities or colleges this rather new type of knowledge infrastructure is not under public ownership, but owned and managed by already existing private research companies or technology centres or even private associations, founded only with the purpose of being the managing board of a polytechnic. One managing board can also control and own various polytechnics as long as financial support is guaranteed. The funding itself is split between central and regional government bodies and the owner of the polytechnic, thus public spending and contributions on behalf of the polytechnic are complementary. But not only financial matters are the duties of the managing boards, they also handle legal questions like negotiations with ministries, chambers and local governments, sign deals or agreements with firms, research institutes and other polytechnics, employ the staff and set up their contracts. Organisational and academic questions however, the actual teaching and the applied research are the responsibility of the polytechnic itself, decisions are made by the director and his teaching staff (Hauser 1995).

Ownership and division of duties are not the only features which characterise Austrian polytechnics and distinguish them from other types of knowledge infrastructure in the country and abroad. Milestones like offered education, obtained degrees and applied research have to be mentioned as well.

Polytechnics confer four-year master's degrees roughly equivalent to those from universities, but combine high level tertiary education and tutoring with vocational training. Apart from studying the students are obliged to participate in various projects using their acquired knowledge and additionally have to do some training on the job in a firm during one term before they have passed their final exams.

In addition to their teaching duties, Austrian polytechnics are also required by law to undertake research in partnership with firms, development agencies, universities and

other research institutes. The research they offer is of a more applied than basic nature, thus it is mostly complementary to tertiary research and it meets exactly the necessities of the SMEs. Depending on the specialisation of the polytechnic this covers technological developments, testing, designing, marketing activities, etc.

After briefly describing the main characteristics of Austrian polytechnics now the links between this knowledge infrastructure, learning, innovation and regional development will be examined more closely. For the discussion of the above mentioned relationships the analytical frameworks of a learning economy and territorially based innovation systems are used.

2. The influence of polytechnics on innovation and regional development

2.1. Learning and innovation

Learning in terms of a process can be distinguished quite differently depending on the specification who is learning, what, how, where and when. In literature it is seen and discussed as a widespread and diversified phenomenon, definitions for various forms of learning like learning by doing, learning by using, individual or organisational learning, etc. are given. Let us concentrate on a specific distinction between two different types of learning which might prove useful in the further analysis: direct and indirect learning (Gregersen and Johnson 1997).

Direct learning on the one hand is a deliberately organised process where knowledge production establishments like universities or polytechnics, research institutes or R&D departments create and utilise new knowledge. This kind of knowledge is of a more codified than tacit nature, although often personal it is passed on and communicated easily. Indirect learning on the other hand is relatively unintended, the new and acquired knowledge is a by-product of economic activities within or between firms. "Important parts of this knowledge base are felt to be tacit, because they emanate from routine based learning by doing, by using and interacting" (Lundvall 1997, p.11). To keep this know-how it has to be utilised as well.

Obviously in a well operating economy direct and indirect learning cannot be regarded as separate phenomena but as complements which have to coexist. The latter applies also to the outcome of learning, because tacit and codified knowledge may be mostly produced in different ways, may have different degrees of stickiness and play different roles in learning processes, but are complementary. Investments in direct learning and the development of new instruments for utilising indirect learning are therefore the characteristics of the learning economy in which learning has become the most important process and knowledge the most important resource (Lundvall and Johnson 1994).

With this useful distinction of the role of learning as a kind of flow and the role of knowledge as a kind of stock it is obvious that learning is connected to innovation. Innovation can be also seen as a process and defined as the introduction and diffusion of new knowledge or new combinations or accumulations of old knowledge into the economy. Innovations may be regarded as learning results, because learning and especially interactive learning leads to new knowledge which is often the foundation for innovative ideas and projects. Some of those materialise in different forms of innovations and are consequently put to use in the economy. The ability to exploit existing knowledge is also a crucial aspect of the learning economy¹ (Gregersen and Johnson 1997).

All the above arguments lead to the proposition that innovation is an interactive process between firms and the knowledge infrastructure, within firms, on a horizontal and vertical inter-firm level, thus between co-operating firms and between producers, suppliers and users. But interaction can only take place if it is embedded in a wider institutional milieu with institutional routines and social conventions (Morgan 1997). These shape the interactive learning and innovation process and can be summarised as patterns of behaviour, common habits, established practices, rules and laws which regulate relationships and interaction between individual and groups in an economy (Edquist and Johnson 1997 b). The importance of routines and conventions - thus of institutions generally speaking - for innovation and economic development has been examined earlier by Putnam (1993) within the concept of social capital. Social capital refers to features of social organisations, like networks, norms and trust that facilitate co-ordination and co-operation for mutual benefit. Social capital fosters the benefits of investments in physical and human capital (for example training and tools that enhance individual ability and productivity) and is a key factor for economic progress and improvement.

Before concentrating on the role of knowledge infrastructure in a modern economy based on learning and innovation the crucial arguments of this chapter will be recapitulated briefly. Learning and knowledge are well connected with innovation which consequently is a vital and significant source of economic development. Innovation as an interactive process and institutions which shape this process are a necessity for a learning economy where the rate of knowledge turnover is high, the diffusion of knowledge is fast and parts of the knowledge stock are changed over short periods.

2.2. The knowledge infrastructure as an important element of a learning economy and in innovation systems

The knowledge infrastructure mentioned before consists of universities, polytechnics, other education and training systems, research institutes, telecommunication networks, databases, etc. (Smith 1996). In the interactive learning and innovation process they are essential partners for firms in co-operations and networks and can be regarded as organisations for knowledge acquisition, diffusion and utilisation. Shorter product cycles and the necessity of continual innovation have encouraged the collaboration of firms and knowledge infrastructure organisations or between firms increasingly over time, although it cannot be denied that persistent attempts for improvements have to be pursued. Together with the institutional support of for example financial and intermediary institutions, technological advice and service systems, tax rules, social conventions etc., the changing role of government policies, like providing the means of learning, the incentives to learn, the access to relevant knowledge, etc. and the assistance of computer and communication technologies, the knowledge infrastructure institutes are responsible for the character and the quality of the learning economy (Gregerson and Johnson 1997).

The existence of interaction in an economy and the way how different actors co-operate and network with each other is also the centre of the concept of innovation systems. They can be described as systems which produce, distribute and use knowledge, introduce it into the economy in form of innovations, diffuse them by different means and consequently gain competitiveness, economic development and growth (Freemann 1995). The performance of an innovation system therefore depends on effective commu-

nication and interaction between actors with different knowledge, skills and fields of expertise.

In literature different kinds of innovation systems have been defined, there are some which are technologically based within a specific industry sector, there are others where geographical aspects and proximity are taken into account. In this paper the latter kind, the territorially based systems of innovation will be the concept to discuss knowledge infrastructure, although both forms are more complements than substitutes.

At a national level knowledge infrastructure may be seen as a significant part of a national innovation system where actors (firms, organisations, government agencies, etc.) interact with each other in ways which influence the innovation performance of a national economy (Lundvall 1992 b). Apart from the knowledge infrastructure there are other key factors which determine the national innovation system: the already discussed institutional set-up, the specific production and consumer demand structure of a country and the wide range of government policies that aim at stimulating innovation, like directly targeted innovation policy or indirect policies focussing on education and training, employment, communication and information infrastructure, etc. All these key elements have sufficiently clear nation-wide background to justify the national point of view (Lundvall 1997, Gregerson and Johnson 1997). The discussion of national innovation systems emphasises the links and exchanges between the key factors; thus flows of knowledge, skills, information, goods, and other inputs and outputs of innovative processes are examined and quantified (Niosi et al. 1993). But the individual actors that actually generate these flows are not analysed in detail and not much concern is given to their motivation and the reasons of their interactions and relationships (Autio 1998). It is therefore legitimate and also important to explore the subsystems of a national innovation system on a regional level. Moreover, parts of the characteristics of a national innovation system (institutional structure, public sector's role, organisation of R&D systems, etc.) can be distinctive in certain regions in comparison with other regions which justifies a regional analysis even more (Cooke et al. 1997, Braczyk et al. 1998).

Thus, if knowledge infrastructure is investigated in a regional context rather than at a national level it may be regarded as an equally important part of a regional system of innovation. Autio (1998) distinguishes two subsystems in a regional system of innovation: the knowledge application and exploitation sphere and the knowledge generation

and diffusion area and also describes external influences by institutions and policies of national innovation systems and international impacts. The knowledge application and exploitation subsystem consists of SMEs and large firms engaged in commercial activity, forming vertical networks and alliances between customers and suppliers as well as horizontal ones between collaborators and competitors. The knowledge generation and diffusion subsystem comprises technology and workforce mediating institutions, research and educational organisations which participate and co-operate in the production and dissemination of codified and tacit knowledge and technical skills. Key elements of a regional system of innovation are the embeddedness in its regional socio-economic and cultural setting and again interactions between and within the subsystems. The flows of knowledge, resource and human capital are vital and may be understood as the driving force of the system leading to a specific "innovation pattern" (Koschatzky 1998, p. 277) and regional development. Following Cooke et al. (1997) the interactions between firms, knowledge centres, promotion agencies, government departments, etc. have to be "associative, meaning there is a regular and two way interchange on matters of importance to innovation and the competitiveness of firms" (Cooke et al. 1997, p. 484). Naturally this interchange has to be based on trust and reliability. Additionally they emphasise the necessity of a financial infrastructure within a regional system of innovation to enable firms to gain financing for investments to generate endogenous innovation.

Interaction and hence innovation processes often have to be initiated and promoted. According to Landabaso et al. (1999) this responsibility could be taken over by the regional government or its development-related agencies and means a "linking of the regional actors and a matching of innovation needs with knowledge supply" (Landabaso et al. 1999, p. 8). That brings us back to knowledge infrastructure and here especially polytechnics, because with their teaching and research functions they operate in the network of regional innovation actors² and play a substantial role in the generation and supply of know how.

2.3. Austrian polytechnics, innovation and regional development - some empirical evidence

With their specific feature of complementary educational and economic goals the position of Austrian polytechnics among knowledge generating institutions is quite unique.

The economic value is based on an inherent flexibility because a less rigid organisational structure makes them less resistant to change and more responsive to industry needs than for example universities.

Polytechnic staff mostly has industrial or commercial experience; industry contacts with former employers are maintained, part-time teachers with current business affiliation are welcomed and sought for. Connections with industry facilitate the design of projects, the vocational training and sometimes the outline and pattern of written student reports. Representatives of business and industry are involved in the evaluation process which takes place every four years and assesses the performance of the polytechnic with regard to educational tasks, organisation of conferences and symposia and also economic output like research and projects results. Only if the monitoring and assessment outcome is satisfactory, the polytechnic continues to exist. The evaluation often also leads - influenced and enhanced by industrial and economic requirements - to curriculum adjustment and development, although of course minor changes and amendments are always possible on request and need not wait till the evaluation is due. This again is strong evidence for the flexibility and adaptability of this knowledge infrastructure.

As primarily regional institutions polytechnics are the leading source of technological expertise and know how in different regions and areas. They participate freely in commercial activities, build and foster business networks to facilitate investments and technology modernisation, establish relationships with private and public agencies engaged in economic development and act as intermediaries encouraging technology transfer and information exchange. Polytechnics are particularly helpful to SMEs, they offer applied research to solve their particular problems, they provide state of the art - information and human resources and accelerate learning and innovation. Polytechnics are better positioned to reach the SMEs than universities, which often prefer not to bother with needs than may not be technologically challenging³. The collaborations are also less intimidating for the owners of the SMEs and therefore less barriers exist to form partnerships.

Let us now have a closer look on the various activities of Austrian polytechnics which can be linked with innovation and regional development. The empirical evidence is based on two pieces of academic research, one survey of all existing polytechnics regarding their technology transfer and co-operation with business and industry in 1997 (Krem-

shofer et al. 1997) and one analysis of all decentralised polytechnics in 1999 (Kremshofer and Unterthurner 1999).

Within the research project in 1997 a questionnaire was sent to 33 polytechnics to build up knowledge about their studies and teaching staff, their present and recent research and co-operation activities with firms and other institutions, their projects and involvement with respect to conferences, symposia, etc. Their respective year of foundation was also taken into account. In 1999 research was focussed on decentralised polytechnics, meaning knowledge infrastructure situated in objective regions of the country and not within the immediate proximity of another tertiary education centre. Interviews with 23 polytechnics revealed again information about research and co-operation activities, projects and facts about the obligatory training on the job. The results of both investigations will be summarised according to the classification scheme of Rosenfeld (1998) who uses the following categories:

- Formation of strategic alliances
- Technology intermediaries
- Upgrading skills and retraining
- Education as a gateway to the workplace

2.3.1. Formation of strategic alliances

Long term partnerships and research agreements are important, 60 per cent of all polytechnics are involved in co-operation and transfer activities with firms, mainly SMEs (Kremshofer et al. 1997). This covers joint research and development in different fields of technology, routine work like testing, equipment demonstrations, analysis of technical procedures, etc., services like renting of laboratories, computer workstations and application software as well as marketing research and reports. The regional engagement of polytechnics varies considerably according to the different technology and business sectors, 50 per cent form mainly regional partnerships, some polytechnics tend primarily to international alliances (Kremshofer and Unterthurner 1999).

The intensity of co-operation with other types of knowledge infrastructure, with research institutions, technology and development agencies, etc. has changed substantially between 1997 and 1999. Whereas earlier the relationships used to be mostly informal,

without much elaboration and somewhat restricted, the collaboration nowadays has intensified, resources have been pooled, specialisation of each partner of the network is the key element. The character of co-operation has a strong regional focus, 86 per cent of the polytechnics are locally engaged.

The fact that some polytechnics have existed longer than others does not appear to influence the amount and intensity of their technology transfer and co-operation activities. The abilities, human skills and business contacts of the polytechnic staff are far more instrumental in setting up relationships and networks (Kremshofer 1998) .

2.3.2. Technology intermediary

Polytechnics also act as storehouse, transmitter and gatekeeper of different fields of knowledge. Within the before mentioned co-operations they use their experience and expertise to offer SMEs consultation and advice on various problems. Some of this interaction is informal, occurring through a phone call or in a conversation at a meeting, some is classified as paid consultancy.

But more important with respect to technology mediation is the role polytechnics play in putting companies and services in touch with one another. They understand themselves as brokers and facilitators, provide neutral environments for association and organise conferences, symposia, workshops and seminars to supply the best source of information. Additionally, informal social events are held in which business people can mingle freely and have a chance to discuss common economic issues, to strengthen existing ties or to create new bonds between them.

By now nearly all polytechnics have established themselves as regional scientific centres that concentrate on the needs of their clients and partners (Kremshofer et al. 1997, Kremshofer and Unterthurner 1999).

2.3.3. Upgrading skills and retraining

Faster changes in industries, shorter product cycles and the rapid development in information and communication technologies lead to a growing demand for skill upgrading and retraining. Up till now 50 per cent of the polytechnics have reacted to the expanding

needs and provide continuing and customised education to individuals and business organisations (Kremshofer and Unterthurner 1999). The seminars are held in the evenings, during weekends or holidays and offer a wide range of subjects, like total quality management, teamwork, software application, languages, law, etc. Often regional firms with similar needs are organised together into training networks, which serves the dual purposes of allowing SMEs to acquire services at lower costs and creating learning communities among companies.

Lately polytechnics have also been engaged in management education in form of summer schools targeting the management of local SMEs and former graduates who want to get a brush up of their knowledge (FH-Joanneum 1999). This strengthens the relationship between the polytechnic and regional employers even more and the classes and seminars help the lecturers remain abreast of current business issues and methods.

2.3.4. Education as a gateway to the workplace

Appropriate tertiary education and training according to the requirements of business and industry is unquestionably the core mission of a polytechnic. Students should be well prepared for their future jobs, thus human resource development has to cover a wide range of technical and commercial knowledge and various soft skills. To meet the economic and industrial needs strong emphasis is put on personal contact with enterprises and organisations, on possibilities of curriculum adjustment and improvement, on projects carried out jointly between firms, teaching staff and students and on a - for all participating partners - awarding and useful students' training period.

Curriculum adaptability and collaborative projects have already been discussed before. Personal industry and business connections are also satisfying and quite notable, because all polytechnics employ more part-time lecturers with current company affiliation than full-time staff, although the latter mostly maintain and cultivate their industry contacts as well. Obviously all these connections do not have an exclusively regional basis but a strong regional tendency on behalf of the part-time staff is to be recognised (Kremshofer et al. 1997).

Such convincing regional evidence cannot be found where the obligatory training on the job and the actual employment after graduating from the polytechnic is concerned. It is

somewhat puzzling that on average only one third of the students spend their training periods in regional firms and still less (10 to 20 per cent of the graduates) start working there (Kremshofer and Unterthurner 1999). So regional enterprises are not the main employers for students and graduates of the polytechnic, the gateway to the workplace has a rather national and to a certain extent international character. As established regional institutions with respect to research, co-operation and mediation, the reasons here may well be an insufficient correspondence to regional education and training requirements.

2.3.5. The empirical results as a starting point for further improvement

If the empirical evidence of the links between polytechnics and regional development is recapitulated, parts of the results may be seen as quite satisfying. The existence of a reasonable extent of regional strategic alliances, the role of polytechnics as technology intermediaries and the adoption of customised training prove that polytechnics have taken on the task of creating a structure to accelerate learning and innovation. Technology diffusion and information flows are facilitated, inter- and intra-firm learning is supported. But the development of a sufficiently trained and educated workforce is a crucial strategy for regional progress and competitiveness as well. Thus, polytechnics should increase their efforts in matching education and training with regional demand and change into more regional gateways for the workplace.

At this point some other academic research carried out recently should be mentioned, which investigated the significance of R&D-infrastructure for the innovation process (Revilla Diez 1999). In eleven European regions the main actors of regional systems of innovation (firms and R&D-infrastructure) and their engagement in co-operation and innovation were analysed. The results, with a particular interest for the metropolitan area of Vienna, are quite remarkable, because the outstanding importance of R&D-infrastructure for regional innovation performance as often pointed out in literature is not reflected. The principal co-operation partners of a firm's innovation process are not knowledge infrastructure institutes but customers, suppliers and the service sector. If there are co-operation activities between R&D-infrastructure and firms, they concentrate on product innovation in form of technological advice, expert reports and testing. Col-

laboration from the R&D-infrastructure's point of view takes place preferably on a national or international level, small enterprises are not the core target group.

Although the impact of polytechnics on innovation and regional development has not been worked out in detail, the results of this research imply again a certain need for improvement of the links between knowledge infrastructure and SMEs. The new and innovative organisational concept of a polytechnic described below is suitable to increase its regional significance and contribution to innovation and economic development.

3. Dual studies in polytechnics - an innovative organisational approach

The concept of dual studies⁴ in polytechnics merges effectively two learning and education contexts, the tertiary knowledge location and the workplace with the practical experiences. To form an integrated unity, the imparted knowledge and qualifications within both learning contexts are co-ordinated between the two partners who take over the task of education, the polytechnic and the respective, mostly regional firm. As high level tutoring is combined with vocational training this concept therefore meets exactly the requirements of the educational standards in polytechnics (Kremshofer 1999).

Dual studies lead to a more effective acquisition of codified and tacit knowledge. Codified knowledge is imparted through the formal educational process at the polytechnics and can be applied immediately at the workplace which enhances the learning results. Tacit knowledge is acquired through opportunities for informal learning like work experiences, exposure to teamwork and social situations in firms (Rosenfeld 1998). Dual studies also provide different channels for the different kinds of knowledge - know what, why, how and who. The facts, the information, the principles and reasons, hence the know what and why, are supplied in the polytechnic. The practical experience, the know how and who is learned at the workplace through day to day dealings, networking and social interaction with colleagues, customers and contractors (Lundvall and Johnson 1994, Goddard 1998).

Dual studies and consequently the combination of the two learning contexts have to be organised effectively. A possibility is the alternation of studying periods at the polytech-

nic with working periods in the firm three or four times a year, with preferably the idea of a boarding school for the studying periods to ensure best learning results. To underline the characteristic features of this training the students should have written agreements with the polytechnic and the respective firm, the latter being a sort of qualification contract for the four-year education period. The demands of the curriculum will also need elements of distance learning and some tutorial weekends during working periods with the possibility of meetings between students and teachers. This fosters competencies for independent learning and offers didactic support if needed (Prisching 1999).

The crucial factors within this concept are obviously the curriculum and the co-operating firms, the former definitely being an essential condition for the company's collaboration. Thus polytechnic and firms should jointly design the curriculum, agree on time schedules, requirements for exams and determine the framework for the training on the job. The curriculum with its accompanying measures therefore will be demand driven by - mostly regional - business and industry. That brings us back to the gateway function of a polytechnic: To emphasise the regional aspects of a gateway to the workplace, the polytechnic has to offer a mix of knowledge, skills and competencies which correspond to the region's economic profile and needs. With the above corporate decision structures between polytechnic and regional firms the concept of dual studies provides an appropriate method for meeting the regional requirements. To increase the regional significance of polytechnics on a long term basis a continuous dialogue with various regional stakeholders (regional employers, authorities, research and intermediary organisations, media, etc.) is indispensable.

4. The organisational approach of dual studies in polytechnics and its contribution to innovation and regional development

Dual studies - as illustrated in the previous chapter- support the formal and informal learning processes and create well-prepared labour pools for the co-operating firms and other regional actors. The new organisational approach also leads to an intensification of the relationships among all regional stakeholders, because their necessary continuous dialogue and the face-to-face contacts encourage the diffusion of ideas and information, plant the seeds for trust-building, strengthen already existing bonds and ties and subse-

quently foster alliances and networking. All this helps to increase the amount of co-operation and transfer activities between firms and the polytechnic, joint projects as well as applied research are facilitated. With the polytechnic as an intermediary and regional technology platform there is also a positive impact on the formation of regional networks between firms themselves. Meetings, workshops and social events organised by the polytechnic help to create trust, reciprocity links as well as mutual understanding and generate a co-operative atmosphere. Among regional actors these are the stimulating elements for interactions, partnerships and networks and the key factors for innovation and economic growth (Lundvall and Borrás 1997).

The importance of interactive learning, personal contacts and networking for the concept of dual studies in polytechnics justifies a final contextual analysis of the links to regional development within the model of the innovative milieu. Similar to their position in the innovation systems discussed before, polytechnics as an infrastructure for education and research play a central role in the innovation process.

An innovative milieu can be explained as a complex network of regional actors with mainly informal relationships and joint goals or visions. Within this milieu collective learning processes increase the local innovative capacities (Maillat 1998). Thus the main features of innovative milieus are networks to stimulate learning and innovation, face-to-face contacts which are necessary to create mutual trust and understanding and shared goals to form bonds between the different actors (Fromhold-Eisebith 1999). Innovative milieus cannot be established or set up, but favourable conditions in a region may initiate and activate its development. Polytechnics in their new organisational forms are able to foster these conditions, because with the whole range of their activities they support the formation of regional networks, take care of the needs of their partners, use their personal contacts for establishing relationships and aim at mutual regional benefits, such as economic development and growth.

5. Summary and conclusions

In this paper I have tried to analyse the contribution Austrian polytechnics make to the development of those regions they are located in. As regional centres for education, training and applied research polytechnics are facilitators for interactive learning, net-

working and collaboration, the essential conditions for innovation and economic growth. They offer tertiary education and vocational training, provide technological expertise and business know how, are involved in technology transfer activities and foster co-operation and network formation.

Yet the impacts on innovation and regional development might even be increased by an innovative organisational approach, the dual studies in polytechnics. Their characteristic features are on the one hand the collaborative design of the curriculum which leads to a better matching of education and training with regional demand, on the other hand the stronger and more effective personal contacts which support trust building and mutual understanding and intensify the relationships between all regional actors.

¹ In a learning economy the role of forgetting has to be considered as well . Sometimes creative forgetting is an essential part of learning and must be integrated, because new knowledge can only be implemented if old knowledge is cleared up or destroyed. Examples are the closing down or modification of organisations, departments or firms, the adoption of new functions or positions, etc. A learning economy is therefore also a forgetting economy.

² Fritsch et al. 1998 name explicitly polytechnics as regional innovation actors and describe them as fostering factors for the innovation performance of a region.

³ Mansfield and Lee 1996, p.1057 speak of a comparative advantage of less prestigious universities.

⁴ The concept of the dual studies per se has already been applied in the German "Berufsakademien" since 1974. These are tertiary academies offering specialised economic, technical or social education and are characterised by alternating periods of theoretical teaching and vocational training. Since 1989 the obtained degrees are equal to those of polytechnics (Ministerium für Wissenschaft und Forschung 1995). The main difference to the proposed concept of Austrian polytechnics is the missing connection to applied research, innovation and co-operation activities with business and industry.

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