

## The ICT Sector Evolution in an Industrial Region of Slovakia<sup>1</sup>

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### Abstract

*The information and communication industry (ICT) has become more significant in the regional economic structure in the last two decades, having a notable impact on other industries. Although young in age, the number of firms or employees in the industry is considerable. Bathelt, Malmberg and Maskell (2004) and Trippel et al. (2009) have highlighted two different knowledge interactions within the ICT sector-local (i.e. local buzz) and trans-local (i.e. global pipelines). Furthermore, this knowledge interaction pattern can be different according to the size, economic structure and history of the cities/regions under consideration. The article is based on empirical research, focusing on the ICT sector knowledge interactions in the region of Eastern Slovakia. It highlights the pre-existing industry related basis of ICT, the importance of local and trans-local interactions, its social capital level as well as clustering potential.*

**Keywords:** *evolutionary economics, knowledge links, old industrial region, lock in, ICT sector*

**JEL Classification:** R11, L86

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### Introduction

The article aims to launch a theoretical construction based on empirical research showing differences of a new sector built on the basis of another dominant sector. The combination of mutually related sectors may be various. It has been shown that even heavy industry such as metallurgy in its pure, rigorous way can be a basis for the inception and development of the information and

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communication technologies sector (ICT sector). There are regional, economic, historical and political factors for the genesis and evolution of the ICT sector. In the case of Eastern Slovakia, the massive centrally planned industrialization and related higher education reform, enthusiasm for automation and control of the production processes and enforced technological isolation of the socialistic block were all at the origin of the ICT sector in the 1960s. The primal technology policy (heavy industry) together with a regional policy of “work and employment for the regional population” resulted in the ICT sector formation as a positive externality of the economic and policy measures.

The particular conditions and the existing knowledge base are supposed to have an evolutionary impact on the character of the ICT sector. The interaction of an industrial sector of heavy industry with a knowledge based ICT sector in an industrially specialized region is fairly remarkable, unique and moreover, significantly influenced by the transition of the economies in Central and Eastern Europe (CEE).

The old innovation and knowledge generation related system in the CEE countries (although not called an innovation system at that time) was based on vertical, centralized relations; top down directed both at the Soviet-bloc and national level. Industrial science and technology became prestigious activities that attracted a massive flow of personnel. The national science and technology systems were supported both from the budget and by means of mandatory allocations into R&D by industries. By the early 1990s, the former COMECON (The Council for Mutual Economic Assistance, economic block of the former communist countries) based on common foreign relations of the post-communist countries dropped to a minimum level and they built concurrent cooperation with West-European countries. The new national R&D and innovation system emerged from the old roots. The collapsing economy was no longer able to keep the research system of the current size (Rabkin, 1997).

## **Methodology**

The results are based on the empirical research conducted within the framework of the research project “Regional Dimension of Knowledge Economics (2008 – 2010). The project has been particularly focused on knowledge links in the ICT sectors of four Slovak regions (Buček, Reháč and Hudec, 2011, p. 380).

The paper has two major objectives. The first is to investigate the origins and the evolution of the ICT sector in the Košice region, referring to processes, structural changes, institutions, dependencies that have been the vehicles of sectoral

transformation and development. The second objective is to analyze the intensity, nature and trajectories of the knowledge links in the regional ICT sector.

Obviously, the study of knowledge links and spatial evolution of an industry requires systematic empirical evidence. A qualitative approach of knowledge biography has been used, tracing the knowledge dynamics from the industry source through the processes and knowledge transfer among the vital actors in the historical perspective. The study is based on the document analysis and in-depth interviews with key regional actors-managers of the ICT firms and supporting institutions. In total, 27 face to face semi-structured interviews were conducted, mapping the knowledge dynamics in the Košice region in the year 2010. The results provide a remarkable insight into the progress and nature of knowledge linkages between the institutions within the regional ICT sector. The achieved results have been codified and interpreted via evolutionary maps.

### **Literature Review and Theoretical Concepts**

The evolution of regional industrial structure in term of entering and exiting industries can be explained in several ways. The evolutionary approach (e.g. Nefke, Henning and Boschma, 2009) stresses the role of technological relatedness of a new and the pre-existing industries. The knowledge creation studies (e.g. Tödtling, Trippl, 2004) explain the nature of regional innovation system and related dominant knowledge base as an explaining factor of diversity of regional economic structures and development also according to specific categories of regions, such as peripheral, old industrial areas or metropolitan.

In contrast to metropolitan regions, the other two regional types (peripheral and industrial) are usually confronted with less encouraging environments and also with a difficulty of the institutional indigence, smaller quantities and quality of specialized knowledge generating institutions and a lower density of firms (Tödtling and Trippl 2005). Such regions display a large diversity of their sectoral and industrial structure and knowledge base structure as well. The variability in knowledge creation in different industries and regions is associated with the knowledge base typology introduced by Asheim and Gertler (2005). To explain the geography of innovation in different industries, a distinction is made between three different types of knowledge bases: (1) analytical, (2) synthetic and (3) symbolic.

The analytical knowledge base is dominant in the economic activities requiring scientific knowledge, if knowledge creation is mainly based on formal models, codified science and rational processes. The biotechnology can serve as a good example of analytical knowledge base, but also in research driven subdivisions

of the ICT sector knowledge generation is based on cognitive and rational processes, analytical reasoning and formal exact models. University-production links, R&D departments and codified knowledge are other typical qualities of the industries built on analytical knowledge base.

The synthetic knowledge base prevails in industries creating innovation through use and new combination of existing knowledge, with an intention to solve particular technical problems (Asheim and Gertler, 2005). The typical industries of that kind are plant engineering, specialized industrial machinery or shipbuilding. Knowledge is more often created in an inductive process of testing, experimentation, computer-based simulation or even through practical working; a deductive process or through abstraction is less common.

The symbolic knowledge base has been introduced recently to account for the growing importance of cultural production. Symbolic knowledge is highly context-specific, such as the interpretation of symbols, images, designs, stories and cultural artifacts (Martin and Moodysson, 2011). The symbolic knowledge base is generally related to the aesthetic attributes of products, design and image creation and relates to cultural and creative industries – media, film making, publishing, music, advertising, design or fashion. An essential part of the work is committed to the creation of new ideas, patterns, artifacts, sounds, records and writings. Hence, the symbolic knowledge base shows a strong tacit nature. The specific knowledge base is considered to shape the innovation processes that are different according to industrial sectors. However, the knowledge bases do not exist as segregated spheres; most industries comprise a dominant knowledge base in combination with the other ones.

The knowledge base in the light or heavy industry is typically located between analytical and synthetic vertices in the Asheim triangle of three knowledge bases (Asheim, Boschma and Cooke, 2007). Metallurgy as a field of materials science is focused on the chemical and physical behavior of metallic elements and their intermetallic compounds. It can be viewed also as a technology of metals and a practical science application. Hence, from the knowledge base point of view classification, the position of metallurgy is between the analytical and synthetic knowledge bases, combining deductive and inductive reasoning, leaning on R&D departments and cooperation with universities.

The ICT sector demonstrates rather broad, heterogeneous knowledge base variability. In general, ICT is a strongly knowledge based sector. The outputs exist in a form of hardware, software, services, writings, systems, images, designs, multimedia, applications, solutions, etc. ICT firms exist which are characterized by an analytical knowledge base on the basis of knowledge links with universities but a great proportion of ICT firms have a synthetic knowledge base

disposition, using their knowledge for mainly incremental innovations in a relation to the value chain actors, suppliers or customers. Additionally, several ICT firms feature a symbolic knowledge base, especially if the outputs are located or targeted on the internet, design, media or advertising.

There is low evidence of empirical studies on the ICT sector in the CEE countries. Some authors have described the importance of the ICT sector in the national economy (Piatkowski, 2006) and discussed the specific features of regional knowledge trajectories in the ICT industry in transition economies (e.g. Reháč, 2009; Skokan, in Tödtling et al., 2010).

The innovation progress in the knowledge based industries, such as the ICT sector, is typically a result of open and interactive processes, involving a number of regional innovation system institutions such as universities and research organizations, public administration, intermediary agencies, customers or suppliers (Boschma and Weterings, 2004; Trippl, Tödtling and Lengauer, 2009).

Focusing on of the Košice region industrial structure, the “old industrial region” is the closest identification concept in the regional typology. Such regions tend to be dominated by traditional old industries (e.g. mining, iron and steel or heavy machinery) and exhibit a lack of more technologically advanced sectors (Tödtling et al., 2010). The old industrial regions (OIR) in Europe have been confronted with their experience of transformation from the heavy industries such as coal, steel, shipbuilding, heavy engineering, which have undergone decline since the 1960s. There are a number of studies on economic renewal in OIRs focusing particularly on Western Europe (e.g. Hudson, 2004), but only a few studies on OIRs transformation in CEE countries, such as in Poland and Czech Republic (e.g. Sucháček, 2009; Domanski, 2003). At the beginning of the transition period, the OIRs in CEE countries feature:

- The heavy industry built in the socialistic era in the 1960s and its decline after 1989,
- The peripheral position to the metropolitan region and EU markets and institutions,
- Centrally planned economy experience,
- Spatial and economic position in relation to the metropolitan region,
- A high number of small municipalities, similar degree of rurality,
- Air pollution caused by the economy structure ,
- High risk of social exclusion, (including high level of Roma population in Slovakia, Romania and Hungary).

Regional research is focused on the adaption in OIRs influenced by “path dependency” and “lock in” (e.g. Birch, Mackinnon and Cumber, 2010). Both concepts have resulted from several empirical studies from the OIRs of Western

European economies. The OIRs often suffer from a mixture of three negative lock-ins: functional lock-ins (inter-firm relationships), cognitive lock-ins (a common negative world view) and political lock-ins (institutions hindering restructuring) (Hassink, 2005; Boschma, 2003). Particularly political lock-in hinders the necessary restructuring processes in old industrial areas. They can be imagined as thick institutional tissues aiming at preserving existing industrial structures and therefore unnecessarily slowing down industrial restructuring and indirectly hampering the development of indigenous potential and creativity (Hassink, 2005).

There is evidence of different interactions between old and new industries in CEE. Firstly, the evolution pattern of the old industries in central planned economies has been strongly influenced by national policy and their location which was not a result of firms' decisions. Another important focus is on the evolution trajectory of old industries, which reached the recession period 30 years later than Western countries. The dominant linkages in the communist countries were inter-regional, organized within particular sectors or within large companies. That created dependence of the regions on the center and reduced regional policy to a sectoral policy for the industrialization of rural peripheries (Gorzalak, 1996).

Because of lack of empirical evidence in CEE countries and regions, the research hypothesis on the Košice region is issued from the OIR research in the Western Europe on lock in. The pre-existing heavy industry is supposed to hinder the development of new industries, including ICT sector.

The following key research questions are studied in the article focusing on the 50 years long period after year 1960.

- Which knowledge source played a central role in the constitution and subsequent development of the ICT sector in the Košice region?
  - What are the region-specific factors in the process of formation and growth of the ICT industry?
  - What is the nature and pattern of the ICT sector in the Košice region nowadays in comparison to its early phase (prior to 1989)?
  - Did the knowledge base change in the region over time?
  - How the pre-existing mature heavy industries have influenced the development of the knowledge based ICT sector in the Košice region?

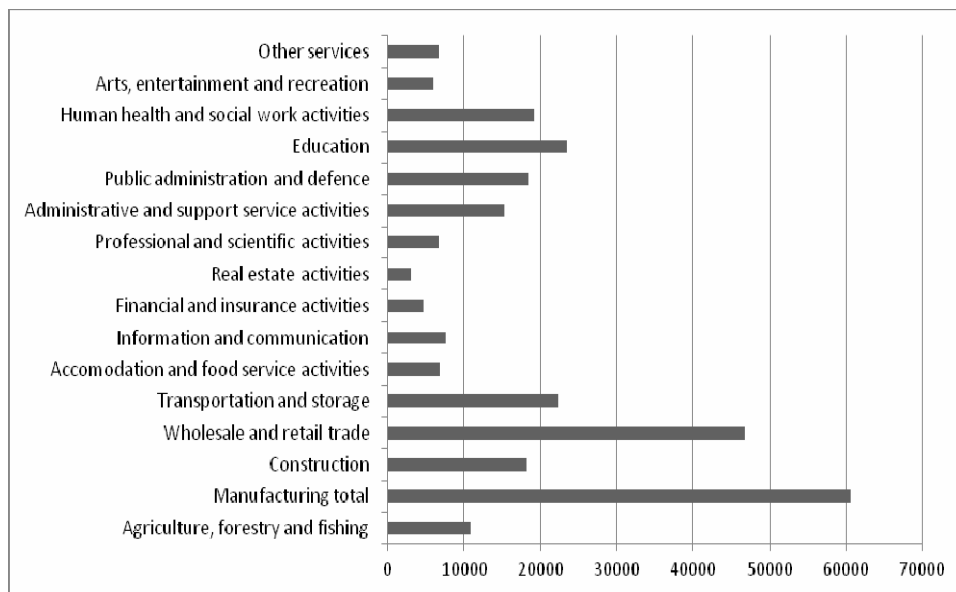
### **The Position of ICT Sector in Košice Region**

The Košice region is located in the East of Slovakia. Its area extends over approximately 13.8% of the territory of Slovakia and has 14% of the total population, thus representing a market for nearly 766 000 citizens. According to the

presented data (Figure 1), the Košice region shows a low level of economic performance (only 87% of the Slovak average in 2007). In 2007, the regional GDP of the broader NUTS II region (Eastern Slovakia) was 46% of the EU-27 average (Eurostat, 2010).

Figure 1

**The Employment in the Košice Region According to the NACE Branches (2009)**



Source: Statistical Office of the Slovak Republic, Regional Statistics Database (2011).

The position of the Slovak ICT sector in international performance comparison is not among the highly evaluated countries. In the complex e-readiness ranking (2009) measured yearly by the Economist Intelligence Unit, Slovakia is in the 36th place (from the 70 surveyed countries) and in the EU comparison, Slovakia is ranked 21st.

The economic policy of Slovakia (in addition to other CEE countries) after 1989 has been predominantly based on exogenous factors such as foreign investments and privatization, EU accession, EU structural funds, etc. Raising regional disparities between the westward located capital of Bratislava and the East of the country is in principle a logical consequence in the medium term.

The technological paradigm of the Košice region has been strongly influenced by the crucial steel industry localized in the region in the 1960s. Near the Košice city, the biggest steel company in Slovakia was built up in 1960 as one of the strategic companies in the former Czechoslovakia. The Eastern Slovak Steelworks (VSŽ – Východoslovenské železiarne), employed around 25 000

employees before 1990 (nowadays the number of employees has dropped to about 14 000). The share of VSŽ in the national Slovak GDP in the 1970s was markedly high – about 9% and generated more than 12% of Slovak exports. Hence, the new equipment and cheap labor qualified VSŽ as internationally competitive. The plant has significantly influenced the expansion of the city population as well (from 75 306 people in 1950 to 214 270 in 1983).

As regards the regional economic structure, the industrialization in the 1960s is still preserved in the region – the manufacturing of basic metals and fabricated metal products in the Košice region is the dominant sector and employer (concentrated around the former VSŽ, privatized by the US Steel company in 2000). The old industrial branch structure of the Košice region has predominated until now, as illustrated in Figure 1.

The Košice region, narrowly focused to industrial production, is supposed to suffering from the negative lock-in effect similarly to industrial areas in the Western Europe. Typically, the domination of large companies is present, the self-sustaining coalition as well as lobbies for sectoral interventions active at a national or supranational level more hindering than supporting the restructuring processes, aiming at removing the incentives to supporting SMEs (small and medium enterprises) and thus paralyzing competition and tranquillizing large industries (Hamm and Wienert, 1989). This is particularly motivating to study in the former centrally planned economies, where the industrial tradition has been injected in big doses quite recently in order to test their progress in avoiding negative path-dependent development. Restructuring was rather spontaneous; the interventions were aimed only at preventing or resolving social and economic collapse. This has led to both a strong, spatially uneven tertiarization process and the dominant role of foreign direct investment as a driving force of restructuring (Lux, 2010).

The ICT industry has become more significant in the regional economic structure in the last two decades as seen in the increasing number and size of ICT firms in the region. Although the Košice region is lagging behind the other Slovak regions in economic development (regional GDP below national average) it seems to be the next ICT center after the metropolitan Bratislava region (Figure 2). In the Košice region, more than 14% of all Slovak ICT sector employees are working, in comparison to only 4 – 6% in other Slovak regions.

In the last analysis 70 percent of ICT firms located in the Košice region are concentrated in the regional capital city Košice. This spatial formation follows the findings of several studies due to the tendency of the ICT sector to cluster geographically (e.g. Boschma and Weterings, 2004). However, the clustering tendency may be less of an attribute of the ICT industry itself, but rather a result



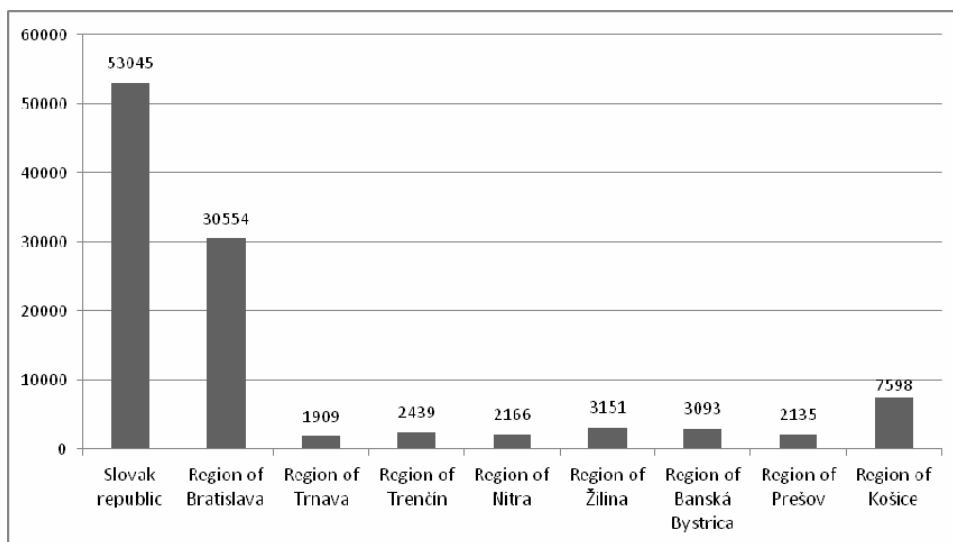
of its demand for skilled labor and immobile tacit knowledge (Maier et al., 2010). The ICT sector could appear in several spatial formations (Lengauer, Tödting and Tripl, 2006) according to the number and size of localized firms:

- Dominating big firms – concentration of several big firms with a high number of employees,
- Industrial districts – a lot of small firms with a low number of employees,
- Clusters – geographic concentration of firms of different size.

The classical cluster definition of Porter (1998) defines clusters as geographic concentrations of firms specialized in a particular field, horizontally and vertically related companies. The nature of the ICT sector in the Košice region has changed over the last two decades from the formation of several isolated regional firms to a developing cluster including regional and foreign firms of different size after year 2000.

Figure 2

#### Number of Employees in ICT Sector in 2009



Source: Statistical Office of the Slovak Republic, Regional Statistics Database 2011.

#### Evolution of the ICT Industry in Košice Region

When analyzing the spatial evolution of new industries, it is important to adopt a dynamic evolutionary perspective. Developing a new industry requires new types of knowledge, skills, capital, markets and inputs, which existing organizations and their surrounding environment cannot provide, because those are oriented towards, and committed to, previous technologies (Boschma, 1997).

The typology for the renewal process of OIRs has been introduced by Trippel and Otto (2009), who distinguish among the three following types of cluster-based renewal:

- Old clusters experiencing innovation-based adjustment processes.
- Diversification into established industries which are new for the region.
- New clusters based on knowledge-intensive industries.

Those types of clusters reflect a miscellaneous degree of regional renewal according to their innovation intensity. According to this typology, a coexistence of traditional (manufacturing) and new clusters (IT cluster) can be seen in the Košice region. The core process that has shaped the regional trajectory is “diversification”. In the following part the evolution of the ICT industry and the cluster based process in the region are analyzed.

#### ***Origins of ICT (before 1990)***

The ICT sector was the part of the “old” industries before 1990. The people working in ICT were situated in business computer centers or industrial research institutes (the leading one called INORGA – Research institute of metallurgy and heavy engineering). The knowledge base was strongly connected with industrial applications in heavy industries at that time. A special position was given to the steel company, which could be described as a vehicle of innovation processes in the region. The political and economic importance of the firm enabled it to adopt in advance not only the newest technologies from the former socialist countries but also in limited way from the western countries. For example, the IBM mainframe S/370in was installed in 1974 in a tense way against the existing embargo. This mainframe was supplemented by the new model IBM 4361 in 1986 which was used till 2002. Before 1990 IBM mainframes were installed only in six other strategic companies in the former Czechoslovakia (automotive company Škoda in Mladá Boleslav, Prague, Ostrava, Bratislava, Kladno and afterwards in the chemical company Humenné). The disposal of the IBM technology enabled contact between informatics and IBM consultants.

Another sources of new knowledge descended from the active collaboration with the German company Siemens. The steel company used to arrange the software engineers practices in Siemens concerned with taking up German technologies.

Hereby the company has played a dual role in the evolution of the ICT industry. First, it has achieved the technological advantage based on its importance. Second, it has strongly influenced the regional milieu. The physical and social infrastructure was developed accordingly in the region and created the preconditions for the later foreign capital location. The regional universities – the Technical University of Košice and Šafárik University have followed the regional development trajectories via lasting adjustments in their curricula.

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Thanks to the Steelworks and the national industrial policy, the ICT sector before 1990 was prevalently focused on industrial application. Also the first programming course (Fortran programming language) was opened at the Faculty of Mechanical Engineering at the Technical University of Košice at the end of the 1960s. The Faculty of Electrotechnics was established later in 1969 and the number of students increased every year, becoming more and more focused on ICT than electrotechnics (from 315 students in 1969 to 3 055 in 2009).

The regional universities provided two kinds of IT curricula:

1. “Technical” curriculum (at the Technical University) focused on engineering, automation and cybernetics, concentrated on hardware and related software areas.

2. “Mathematical” curriculum (Šafárik University with a tradition of mathematical and physical science) oriented to abstract and exact reasoning and concentrated on mathematical and theoretical basis of computer science.

The computer science development has brought several reputable research results, such as the special-purpose computer SIMUL developed at the Technical University of Košice, which has won awards at two international exhibitions of patents and inventions (Internemo at Cologne in 1972 and Salon International des Inventiones de Genève in 1972). The research team dealt with a multiprocessor hybrid systems based on the RPP-16 computer and the analog computer MEDA 41. The research orientation of that team was later transformed into the development of the robot control systems. The control system MUDRS was used in the robot system MYMR 50, which was awarded the gold medal at the International Fair in Brno in 1986. (Dujnič et al., 1999).

### ***The Diversification Period (1990 – 2000)***

In the empirical research we have identified three main engines of regional knowledge before 1990, which dealt with IT research and practice. After 1990, the economic transformation to a market economy, followed by the atomization of the steelworks (1) and industrial research institutes (2) (including INORGA), brought opportunities for people from IT centers to start their own businesses. The third vehicle is represented by the computer engineers from the regional universities (3) that gave birth to two important spin-offs – Elfa (employees from the Faculty of Electrotechnics and Informatics at the Technical University of Košice) and VSL Software (employees from the Institute of Informatics, P. J. Šafárik University).

This period might be associated with a process of diversification. The term diversification is defined as the emergence of clusters in established industries in areas which are, however, new to the region (Trippi and Otto, 2009). During the analysis of the regional diversification character, the unrelated diversification has

been identified (development of a new sector which is not related to those that already exist in an area) driven by a combination of exogenous and endogenous factors.

There were several regional companies established during the period 1990 – 2000, focusing mostly on the administration of business IT systems and the sale of hardware and software. The most successful companies were able to develop their own complex software application e.g. Telegrafia (development of warning devices and related software), Lynx (security of information systems), ICOS (company information systems), Novitech (installation and implementation of LAN and Novell based solutions). The mentioned firms are all of medium size and considered as “old” born at the former industrial roots of steelworks, INORGA or TESLA (electrotechnics) basis. The former western partners of the VSŽ also became the first foreign investors in the regional IT sector – IBM in 1990 and Siemens PSE in 1995 that established their subsidiaries in Košice, following the cooperation before 1990. One of the respondents in our research named the period 1990 – 2000 as the “IT Klondike”. The existing firms capitalized the advantages of new opened sectors with relatively low level of competitiveness.

#### ***The Arrival of the Big Players (2000 – 2010)***

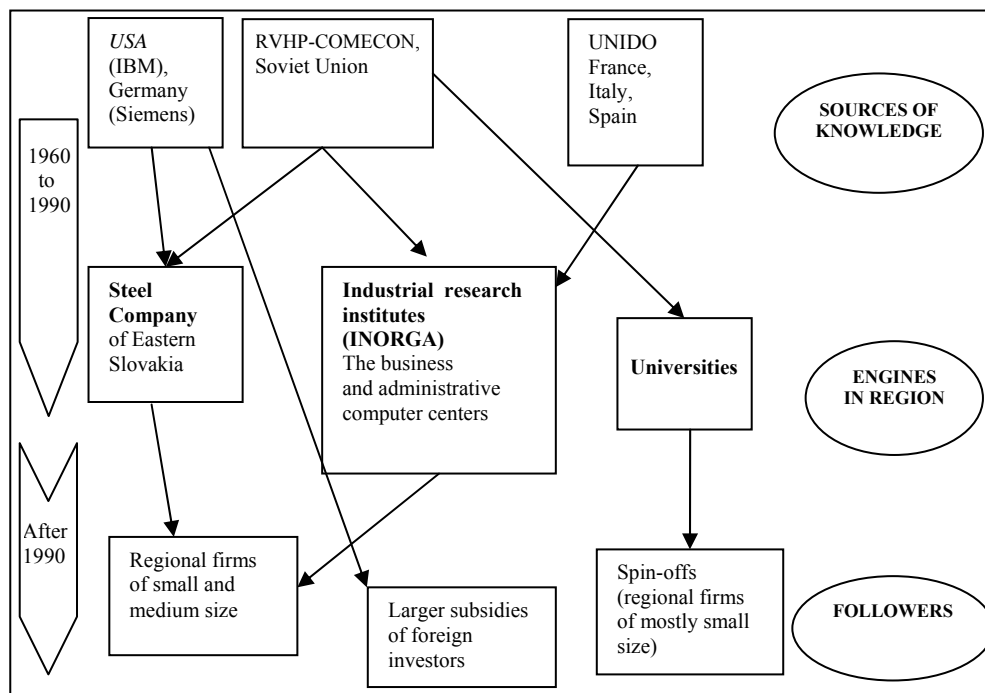
An incentive for reshaping the ICT sector was the integration of Slovakia into the European Union. After the year 2000 the creation of many small and micro IT firms of regional origin can be observed. Some of them were spin-offs of the European Framework Programme projects (e.g. InterSoft), but this was a period of a new generation of graduates or self-made young men educated on computer games. The majority of the new small young IT firms are naturally connected with new programming languages, the growth of computer games, internet and mobile technologies. As an example – the young graduates elaborated on new technology (e.g. DATAcrea – game software “Golf club”). The orientation of IT firms has shifted gradually to web technologies and telecommunication services. In this period the positive effects of European integration can be seen. According to the European objectives (Lisbon Agenda) the process of e-government started and the orders for the public administration stimulated IT business markedly.

After the Slovak EU accession (2004), the key players entered into the regional IT market. In 2005 several firms entered the regional IT market at the same time – Ness KDC (250 employees) and RWE IT (215 employees), established their subsidiaries. In 2006 the process was continued with German T-Systems (2 000 employees) and in 2007 Finish developer of Nokia Software IXONOS (170 employees). All of them declared that they would increase their number of employees.

The arrival of the T-Systems service center has definitely changed the nature of the regional ICT sector. The regional manager of T-Systems, who has created the most rapid growing foreign subsidy in Slovakia, grew at the computer and system department in the VSŽ steel works in the 1970s. After 1990 he managed the IBM subsidy in Košice and Arab Emirates. The stories of other firms could affirm the crucial role of social capital in regional knowledge trajectories.

T-Systems initiated the dialogue between actors of “Triple Helix” (universities, public administration, and firms) and supported the establishment of regional association under the name “Košice IT Valley”. That was a very first clustering initiative in the region and at the same time was a publicly surprising effort to change the former metallurgical image of the Košice region for a modern ICT picture.

Figure 3  
ICT Evolutionary Tree



Nowadays, the IT Valley can be considered as a cluster with one leading firm (T-Systems). The participating firms show different patterns of cooperation. Foreign firms are more active in association with the “IT Valley” and more involved in regional activities, which are not connected with business (e.g. relationships with universities). But they are less interested in regional business

cooperation and they are fairly technologically locked. Regional firms are less active in “cluster” association but in reality, they cooperate together at the regional level although based only on the business contracts. Some regional firms have supported the establishment of another cluster initiative “Biterap”, more focused on the old system and automation partnership.

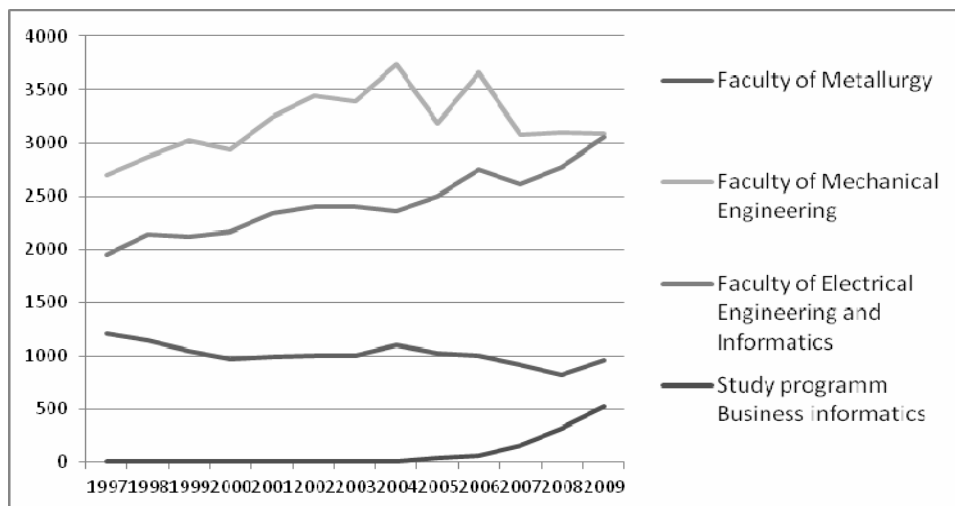
### ICT Sector: Changes over Time

The formation of the new ICT industry has been heavily supported by a re-configuration of the knowledge infrastructure. The research and educational organizations, earlier strongly oriented to industrial application have changed their orientation to informatics.

During the period 1969 – 2009, the content of IT education at the Technical University of Košice was dramatically changed from a system of engineering and automation to one of informatics and business informatics, causing de-industrialization of their curricula according to societal changes, economic transition and market needs. The position of the presented industries in the regional economic structure was followed by changes in the amount of graduates and students at related faculties at the Technical University of Košice (Figure 4). The demand for a labor force in the ICT sector has increased rapidly since 2004. In 2005, a new study program “Business informatics” started, replacing the former old industry-computer marriage with a softer and young economics-computing relation.

Figure 4

#### The Number of Students at the Technical University of Košice (1997 – 2009)



Source: Technical University of Košice (2010).

The curriculum provided at the Šafárik University has remained similar until now, based on elite mathematical theory as well as the number of graduates (about 30 per year). Using the typology of different knowledge bases we can characterize the knowledge base in the IT sector before 1990 into two types – synthetic (graduates from the Technical University) and analytical (graduates from Šafárik University). After 1990 the knowledge base was transformed in its content but not in its character. It is still based on synthetic knowledge attributes but not for its realization in industrial applications, technologies and solutions. The modern core business activities of ICT firms in the region are IT services and business information systems.

The software houses of several firms (NESS KDC, IXONOS) declare their needs for software development based on analytical knowledge. There is a developing mass of symbolic innovative knowledge base, small firms oriented to game development, advertisement, multimedia – creative industry (e.g. 3D People).

Table 1

**The Evolution of ICT Sector**

<b>IT sector features</b>	<b>Origins of ICT (before 1990)</b>	<b>The Diversification Period (1990 – 2000)</b>	<b>The Arrival of the Big Players (after 2000)</b>
<i>Key firms</i>	Steel company, INORGA	Siemens, IBM, AT&T, ICOS, VSL Software, Elfa, Telegrafia, Novitech	T-Systems, ACCase, RWE IT, NESS, IXONOS, Datacreo, 3D People, Antik
<i>Size/Origin</i>	Large companies	Regional companies of small or medium size, few foreign subsidies of medium size	Subsidies of international concerns of big or middle size Regional firms of medium or small size
<i>Field</i>	System and process control	Selling of hardware and software, IT business processes	Software development, complex IT solutions, web technologies, IT services
<i>Knowledge sources</i>	COMECON, IBM, Siemens,	National and regional sources	Foreign subsidies – concern laboratories (Germany, Israel, Finland, USA). Regional firms – national and regional sources
<i>Universities</i>	System engineering, automation, robotics, technical cybernetics	Computer science	Electronics, business informatics, cybernetics, telecommunication, energy sector
<i>Customers</i>	State companies RVHP-COMECON	Slovak firms and banks	Public administration in Slovakia, EU, world
<i>Policy</i>	State, automation	National	European, national, regional
<i>Knowledge base</i>	Synthetic and analytical	Synthetic	Synthetic, analytical, symbolic

Source: Own compilation.

The foremost conceptual works on the geography of knowledge linkages have introduced two sources of knowledge – “local buzz” and “global pipelines” (Bathelt, Malmberg and Maskell, 2004). In the recent work (Trippel, Tödtling and Lengauer, 2009), the concept went beyond the buzz-and pipelines concept and

suggested a differentiated typology of knowledge linkages, distinguishing among market relations, formal networks, spill-overs and informal networks. The main knowledge sources before 1990 were linked to the former COMECON (the Council for Mutual Economic Assistance for countries of Eastern Bloc) and particularly to several western firms (Siemens, IBM). Nowadays the “global pipelines” have spread through incoming investors since 2000. The “local buzz” is based mainly on market relations between regional firms, which are strongly influenced by informal networks.

According to the research results, the interactions between the universities and ICT firms are often and regularly, but focused on the education process not on research and development issues. In comparison to the time before 1990 the natural knowledge links between the universities and industry based on industrial application were broken. The ICT firms of middle size usually set up their own departments of software development rather than collaboration with universities. The research at the universities is oriented to specific research topics which are not necessarily connected to practice.

## **Conclusion**

In this paper we have studied the structural changes in the Košice region from an evolutionary perspective. The Košice region, as an industrial region focused on metallurgy and steel production, has been able to attract ICT firms and seems to be the second important ICT region in Slovakia. The opening of a new technological paradigm could stop the regional brain drain, which was typical for the East Slovakia region after 1990.

The results of the empirical analysis of the ICT sector evolution provide an evidence for the formulated hypothesis justification. The research resulted in view, that old mature industry could be a knowledge base for a new knowledge intensive sector. In this sense the region was able to partially overcome the concept of lock in and use the previous technological paradigm for opening the perspective for raising the ICT sector. A crucial role has been played by the regional universities with sufficient capability in providing a well-educated labor force, which has been a key localization factor for the ICT sector.

The evolution of the ICT industry in the Košice region was highly dependent on the regional factors, especially on the location of the steel company in the beginning of 1960. The investment has had an enormous impact on growth of the region. Three phases in the evolution of the regional ICT sector have been identified. Over the last two decades, the formation of several isolated regional firms resulted into a developing cluster including regional and foreign firms of different size after year 2000. The crucial knowledge source for the ICT sector



was connected with the steel company, taking advantage of the external links with western countries which enabled technological development. The synthetic and analytical knowledge base in the ICT sector has been enriched by the symbolic knowledge base as well, on account of the computer games development and web design provided by a number of small innovative firms.

In drawing more general conclusions from the findings of the paper, we might argue, that the policy makers in the Košice region have had to facilitate the networking among the old and new ICT generation. We found a lot of examples of informal contacts but there is still only less developed knowledge exchange between regional actors especially between universities and firms. The quality of partnerships developed in the framework of old industries has still not been achieved by the ICT sector, but the rapid opening of “global pipelines” could serve as an engine for intensifying “local buzz”.

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