Inštitut za ekonomska raziskovanja
Institute for Economic Research

Kardeljeva pl. 17, SI-1000 Ljubljana

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Peter Stanovnik
Nika Murovec

WORKING PAPER No. 49, 2010

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Editor of the WP series: Boris Majcen

Ljubljana, September 2010

* The study was produced within EURODITE Integrated Project – Sixth framework programme, priority 7: Citizens and Governance in a Knowledge Based Society. The project was coordinated by University of Birmingham (dr. Stewart MacNeill) and conducted by 23 partner institutions.

† Institute for Economic Research, Ljubljana, Slovenia; e-mail: stanovnikp@ier.si

‡ Institute for Economic Research, Ljubljana, Slovenia; e-mail: murovecn@ier.si

CIP – Kataložni zapis o publikaciji
Narodna in univerzitetna knjižnica, Ljubljana

004:001.891(497.4)
005.62(497.4)

STANOVNIK, Peter
Territorial ICT knowledge : dynamics in Slovenia / Peter Stanovnik, Nika Murovec. – Ljubljana : Institute for Economic Research, 2010. – (Working paper / Inštitut za ekonomska raziskovanja, ISSN 1581-8063 ; no. 49)

ISBN 978-961-6543-77-4
1. Murovec, Nika
252494592

Abstract

The paper deals with the fundamental questions concerning ICT knowledge dynamics in Slovenia. The main focus is on generation, application, transfer and diffusion of ICT knowledge. The advanced ICT products and services were examined at national level and several case studies were conducted at firm level.

Given the slowdown of economic growth in ICT sector during the economic crisis, the radical structural adjustment is the must for all stakeholders: government, business enterprises and knowledge institutions. Changes in economic structure imply ICT activities with higher value added, internationalization of the sector through market driven R&D, inward foreign direct investments and formation of strategic alliances within global vaue chains. Knowledge institutions (universities, public research institutes) should pursue besides analytical knowledge (basic research) also symbolic knowledge (applied research).

JEL classification: D83, O23

Keywords: knowledge dynamics, information and communication technologies, national innovation policy, knowledge based economy

1. DESCRIPTION OF THE TERRITORIAL KNOWLEDGE DYNAMICS AND THE RELATED FIRM KNOWLEDGE DYNAMICS

The aim of this paper is to answer the fundamental questions regarding the ICT KD (knowledge dynamics) in Slovenia. This study's main focus is on advanced ICT products and services which were examined also under firm knowledge dynamics (FKD) case studies. The case studies comprised innovative firms producing telecommunications equipment and different ICT services.

In order to ensure a better comparison and benchmarking with other European regions, the whole country of Slovenia is treated as one NUTS 1 territory. Further regionalisation of the country is still under way. It should be stressed that when we speak about "regional" in our TKD (territorial knowledge dynamics) means national. This is important to mention as no territorial units were formed at NUTS2 or NUTS3 level and all relevant policies were conducted at national NUTS1 level. The only exception is drawing from cohesion fund. In this case the country was divided into 2 regions (western and eastern).

The first part of the chapter one begins with a brief description of the TKD which will be explored, i.e. Slovenian ICT TKD. The focus is on the analysis of the technical/technological, social, territorial and policy dimensions. Within the technical level, the problems about products/services/technologies will be discussed. Within the social level we will describe the key players and governance modalities in the region and especially in the ICT sector. The territorial level will deal with the questions where the internal and external knowledge players are located and what kind of spatial interactions occur. Finally, within the policy level the main policies which play a direct or indirect role in the territorial knowledge dynamics will be analysed.

In the third part of the first chapter EURODITE hypotheses and specific hypothesis are discussed.

The second chapter is intended to provide future stakes about the TKDs in their broader context.

Concluding chapter is dedicated to synthesis of the research. The authors proposed few thoughts and ideas how to shift existing TKD to new knowledge based paradigm in Slovenia.

1.1. Understanding the economic, technical and social dimensions of ICT

1.1.1. General description of the ICT TKD and of the economic and social stakes around it

ICT TKD deserves in Slovenia and elsewhere special and continued attention because of its impact on knowledge based trajectory, because of relevant role in manufacturing and service industries and not least due to the high level of R&D investment and permanent innovation. ICT is important for its inherent cross-disciplinary and cross sectoral nature and for its new ways of producing, trading and communicating.

In the period 1995-2005 Slovenian ICT market has grown considerably (above 9% average yearly growth rate). The share of ICT value added in the business enterprise sector 2005 reached 7,2%. According to GVIN, AJPES for 2007 the share of ICT companies in the total net income was 2,6%, in EBITDA 6,1%, in net profits 4,9%, in the capital assets 4,2% and in employment 1,4%. According to EUROSTAT there were in Slovenia located 2825 ICT firms employing 24 670 people. This represented 7,3 % of total industrial employment.

Slovenia has from the standpoint of information society reached in 2006 relatively good performance: 63,3 internet users per 100 inhabitants, 24% use of e-shopping, 61% of households with personal computer and 51% of households with access to the internet and 12.6 internet bandwidth per 10.000 inhabitants. Our research focus was oriented on the knowledge dynamics in production and use of ICT products and services as well as on the problems of gender issues.

The stakeholders in ICT sector (manufacturers of HW and providers of SW, universities, research institutes, technology centers, center of excellence, public agencies, telecom operators) have diversified organizational and ownership structure. There is no specific hierarchy relations among ICT stakeholders. National council for science and technology which should be the leading advisory body has not in the last years played any role in ICT governance issues. Business enterprises are organized voluntarily in Chamber of economy, in 2 consortiums called “technology networks” (ICT and process controlling), in 4 technology platforms (ARTEMIS - embedded systems, NESSI - software and IT services, NEM – networks and electronic media, e-Mobility). Three public agencies have different roles: ARRS is entitled for funding R&D, technology agency (TIA) for technology and innovation and Public agency for post and telecommunications has mostly regulatory function.

ICT knowledge dynamics in Slovenia is important for many reasons:

- intensive use and full exploitation of ICT can enhance the competitiveness of private industries and public services because of its ubiquitous and pervasive nature;
- the employment of highly educated labour force (for example system engineers, programmers) would alleviate the problem of unemployed highly educated workers;
- ICT has the impact on increase of export intensity of products and services and on higher value added in export industries;
- the shift to new knowledge based paradigm based on more intensive networking of stakeholders and on new ICT generations;
- increase of IT networked readiness (see WEF the Global IT Report 2008/2009).

1.1.2. Technical novelties and specialisation process

TKD in Slovenia inherited long industrial tradition from co-existence in former Yugoslav federation. Since the second half of the 20.century the whole country got industrialised with very small share of agriculture and services sector. Despite the fact that in the early 90s huge industrial conglomerates (for example corporation Iskra with over 30 thousand employees) broke into smaller private firms, a lot of accumulated knowledge in the field of electro, mechanical engineering and electronics remained anchored in the main industrial centers: Ljubljana, Maribor, Kranj. Opening of the domestic market at the break of century and after the EU accession brought about many new emerging SMEs, new market opportunities and ICT challenges.

The country's relative openness towards Western countries has enabled also a quite early development of the ICT market and advanced ICT infrastructure. In the 90's, Slovenia had good chances to catch up with the leading European countries in the ICT field. The educational system has improved, people were becoming computer literate and on the verge of the new century, Slovenia was the first among Central and Eastern European countries in keeping pace with the advanced EU countries regarding the number of personal computers, mobile phones, internet penetration in schools and libraries. In the last ten years, however, Slovenia lagged behind the most developed countries. Telecommunications indicators still rank in or above the EU average. Slovenia enjoys high levels of fixed-line, mobile and internet usage. Nearly half of Slovenians use the Internet at least once a week and even 81% among the 16 to 24 years old; 54% of Slovenian households and 96% of Slovenian companies have an internet connection and 34% of the households and 75% of the companies in Slovenia

had a broadband internet connection in 2006. 62% of the companies with more than 10 employees have its own web page; also e-shopping has widely spread in the last two years. Recent liberalization of the telecommunications market has enforced competition but there is still a lack of a large scale competition. The most important knowledge base in the region is software development. In the last available ICT sector analysis (GZS, 2006) characterized the Slovenian ICT market as a developed and mature market; the share of IT services in the IT market was high (36% in 2004). The value of the ICT market has increased from 1.409 million euros in 2004 to 1.556 million euros in the 2006. Regarding the telecommunication market it has to be emphasized that the Slovenian telecommunication producers are oriented towards equipment manufacturing. The number of the employed in the ICT has been increasing (at a rate of 4,1% in 2002-2004) and 40% were employed in the IT services segment. Also the total turnover of the ICT sector has been increasing (6,9% growth rate in 2002-2004) and accounted for 4,6% of the total turnover in 2004, whereas ICT profits accounted for 5,3% of all profits. The ICT sector has produced twice as high value added per employee as the rest of the economy.

TKD in Slovenia kept to follow the new generation of ICT technologies. The sector is heterogeneous and complex; it comprises both manufacturing and service firms and several firms produce both goods and services thus blurring the border between the manufacturing and services.

From OECD ICT priorities (Vickery, Wunsch-Vincent, 2008) we can notice the broad spectrum of present and future global R&D ICT orientations and trends actual also for the TKD in Slovenia.

Slovenian development strategy, European technology platforms and FKD gave new arguments for specialisation in the following areas: computing systems and architectures (embedded systems, autonomous computing systems), network infrastructures (wired and wireless broadband technologies, next generation networks), software engineering, digital content technologies (customized and context-oriented information), converging technologies and scientific disciplines (ICT enabling scientific research).

In the past there has not been clear vision regarding which industries should be the countries priority. Since the level of the specialization of the economy has been quite low, consequently also the existing knowledge in the country is much diversified. Only in the recent years the debates about whether it is best to specialize more or to stay diversified and invest in a broader range of industries have emerged. One thing seems

clear, a greater emphasis should be given on the field of technology development. The data shows that the trends of the number of graduates in the field of S&T are not encouraging; Slovenia is in this indicator even increasing its lag behind the EU average. Besides that, the universities in Slovenia are quite rigid and restructuring to new knowledge demands is too slow. The industry-level data shows that the most important sector is manufacturing, where more than a half of the value added is created by only four different activities: manufacture of metals and metal products, manufacture of chemicals and chemical products, manufacture of electrical and optical equipment and manufacture of machinery and equipment. Despite gradual deindustrialization the importance of manufacturing industry in Slovenia remains higher than the EU average. High-tech industries accounted only for 13% of the cumulative value added in the 2005, whereas low-tech industries still account for a third of the value added. This is a cause for concern and it shows that the process of ICT restructuring in Slovenia is progressing too slowly.

1.1.3. The players' interactions, territorial relations, mobility and anchoring

Slovenia's geographical position in Central Europe is one of very favourable characteristics for the mobility and anchoring of new knowledge. Besides relatively good physical infrastructure (highways, airports) and scientific infrastructure (universities, research equipment, supporting intermediary institutions) TKD needs more up to date technological infrastructure (labs, venture capital, friendly environment for high tech companies, for new start ups and spin offs, internationalised R&D etc.).

There is no concerted hierarchy among the players nor consensus building in strategic ICT issues. The role of ministries is limited mainly for general policy issues, regulations and R&D funding. Manufacturers of ICT products and IT service providers are driven mostly by domestic demand which became quite sophisticated in the last years. State ownership in domestic telecom operator caused oligopolistic market structures which were abolished in the last 3 years. Because of small size of domestic market, low availability and mobility of skilled labour and rigid institutional framework we can speak about the insufficient TKD in the great part of ICT sector. There is a danger of brain drain in the near future. Contrary to classical industrial branches trade unions in ICT sector do not present strong stakeholders. It should be mentioned the rising roles of Consumers Association, other professional associations and civil society institutions constituting an informal social power and thus enhancing the preparedness for information society and IT network readiness (see Global IT Competitiveness Report, WEF, Geneve 2009).

The important roles in the ICT sector have the Association for ICT at the Chamber of Commerce and Industry of Slovenia, Center of Excellence, Institute for Telecommunications, and 2 technological networks, (ICT and process controlling) which were all designed with a purpose to improve the ICT knowledge dynamics in the country. The ICT Association with its sections for the telecommunications service and equipment providers, internet services providers, software providers comprises more than a thousand member companies. The Institute for Telecommunications combines experts from different fields of telecommunication and other activities with a purpose to stimulate the development of this field. The Institute also develops different applications and software solutions. The ICT technological network has 47 members and was designed with the main purpose to bring together knowledge, technologies, people, companies and institutions in order to enable a better knowledge dynamics in the ICT field and by that provide better project results for all members. Among the members are also three research institutes and five faculties. Despite different bridging institutions the main obstacle for the knowledge dynamics remains the strong feeling of competitiveness among different companies which makes some of them very reluctant to reveal almost any data. Among research institutions, the most important is Jozef Stefan Institute with its department for electronics and information technologies including sectors for communications systems, computer systems, knowledge technologies, systems and management, open systems, networks and intelligent systems. The Institute also has its own postgraduate school. The enrolment into the faculties and programmes, related to the ICT field, is too low to meet the needs for technological breakthroughs.

2825 companies were operating in the ICT sector in Slovenia in 2003. The largest companies in the information technology sector were Src.si and Hermes Plus while the largest in the telecommunications sector were Telekom Slovenije, Mobitel, Iskratel and Simobil. The advantages of the Slovene ICT companies are their flexibility and analytical knowledge, while their main disadvantage is the lack of symbolic knowledge and mutual cooperation. The FDI in the ICT sector are lower compared to Eastern or Central European average. Citizens are more interested in the information society than the average EU citizen and are open towards the technological novelties, which enable a relatively quick diffusion of new technologies (such as Internet TV, 3rd generation mobile telephones…). The Slovenian companies, on the other hand, introduce ICT novelties too slowly to improve their global competitiveness. Since the 2004 election, the main executive body, responsible for the STI policy has been the Ministry of Economy (with its Enterprises Development and Competitiveness directorate) which later delegated some of its tasks to the Ministry for Higher Education, Science and Technology and the Agency for Technology. The Ministry for information society was

abolished. The government advisory body in matters of STI policy is the National Science and Technology Council which has not played any coordinative role among the stakeholders. There are several intermediary institutions, such as the Slovene Enterprise Fund, Agency for Scientific Research (ARRS) and the Slovenian Technology Agency (TIA). The facilitating institutions are: Intellectual Property Office, Agency for Entrepreneurship and Foreign Investment, Technology Parks/Centres, Associations of Innovators/Researchers, Chamber of Industry and Commerce, the Slovenian Innovation Relay Centre and different clusters and incubators. Another important player in the process of knowledge dynamics are R&D performers, which include 4 universities, three independent higher education institutions, and 17 public research institutes. Even though there are numerous bridging institutions, the cooperation between public research and the business community is insufficient. One of the main problems is slow restructuring of the public R&D sector away from programme financing towards project financing of market driven research. The business sector employs 46% of all researchers (and 50% of all women researchers). Micro enterprises are by far prevailing in number and present more than 93% of all enterprises. There are only 305 large companies (0,3% of all companies) employing more than 250 people per company or 470 large companies (0,05%). The entrepreneurial spirit is not traditional part of the Slovenian culture, but the attitude towards entrepreneurship, innovativeness, risk taking and overcoming failures, is slowly improving. Slovenians are quite open for novelties as individuals, whereas the companies tend to be less open and flexible and the universities very rigid.

The main stakeholders of ICT TKD are shown in the figure below.

ICT stakeholders in Slovenia

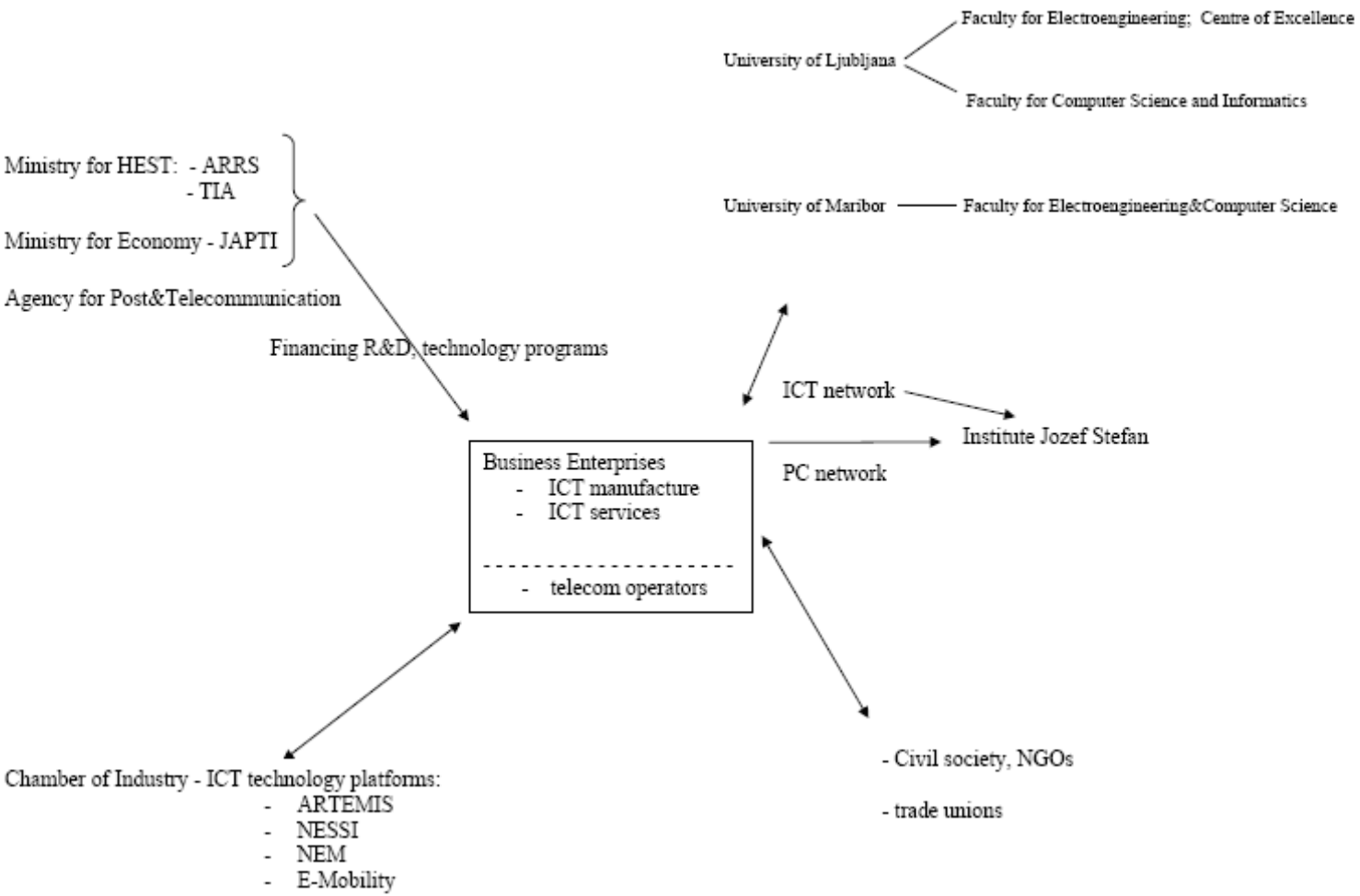

Table 1: Leading domestic and foreign owned ICT companies in Slovenia in 2005

Actual I.T.	software provider
Ad acta	IT services, software provider
AGB Lab/AGB Group	HW manufacturer
AMIS/Amisco	internet service provider
Cosylab	development of new generation technologies
Debitel Komunikationtechnik	telecommunication service provider
Ericsson	telecommunication systems and products
Hermes Softlab	IT services
Hewlett Packard	IT services and products
IBM Slovenia	IT services
INEA	IT services, process controlling
Insilica	Design and development of PCB
Instrumentation technologies	software provider
IPS Ljubljana	telecommunication systems
Iskratel Kranj	telecommunications equipment and services provider
Iskratel Electronics	telecom. equipment manufacturer
Microsoft	software provider
Mobitel	telecommunication service provider
Datinvest ventures cap.holding	software provider
Oracle	software provider
Perftech	software provider
S&T Slovenia	IT services
SAP systeme	software provider
Si.Mobil/Mobilcom	telecommunication service provider
Sinfonika	telecommunication and internet services
SIOL	internet service provider
SRC.SI	IT services, system integration
Špica International	IT services
Telekom Slovenija	telecommunication service provider
Tipro keyboards	hardware manufacturer
Ultra	mobile assets management solutions
UPC Telemach	wide spread communication services

Source: IER data base

1.1.4. Technical novelties, territorial relations, mobility and anchoring

In Slovenia there are some local centres where most of the ICT knowledge dynamics unwinds. In the recent years, besides the capital Ljubljana and second largest city Maribor, the more intensive knowledge dynamics started developing also in some other parts of Slovenia. This is due to the establishment of several knowledge institutions (universities, research institutes, development agencies) also in other parts of the country. Besides local support institutions also new universities and other higher education institutes were established (Nova Gorica, Celje, Koper, Kranj). Still, the

capital Ljubljana and Maribor stand out as far as knowledge dynamics is concerned in ICT and other related sectors. The majority of students still studies in the capital and a big share of them also stays there after the graduation. Their chances for the employment are best in Ljubljana, since most of the companies are situated there and so are also the majority of R&D performers. Also the mobility of the workers between companies is much higher in Ljubljana then in other areas. Still, the mobility of employees in Slovenia is lower than the EU-15. While an average employee in the EU changes 4 jobs in his career, in Slovenia the average is less than three. The interregional geographical mobility of workers is slowly increasing. In 2004, 10% less people worked in the same community where they live, compared to the year 1999, although most of that workforce daily commutes to Ljubljana from other smaller communities. Besides Ljubljana, there are also some other bigger cities, such as Maribor, Koper and Celje, where the knowledge dynamics is relevant. Outside the main urban areas and traditional industrial areas, the knowledge dynamics is rather low. Foreign workers, who migrate to Slovenia mostly have only basic education (more than 90%) and almost 95% of them come from other ex-Yugoslav republics. Among the highly skilled professions, there are only four which attract a certain amount of foreigners – engineering, electrotechnics, medicine and economics. Most of the important Slovenian companies (in ICT and other sectors) have established their subsidiaries in other West Balkan countries due to good knowledge of the culture and language.

1.1.5. Interactions between the FKD and the TKD

We found some obvious interrelations and interactions between the ICT FKD and the ICT TKD according to 3 case studies of good practice. There are several reasons for these interactions:

- first, the nature of ICT is cross-cutting and ubiquitous and in this way it enables the diffusion at macro, mezzo and micro level (use of individuals, business and government);
- second, low costs of production of ICT knowledge enable its transfer into geographically distant locations (we can say that Slovenian FKD cases are using “flying geese model” in transferring the economic valuable knowledge in more distant locations);
- third, ICT allows productivity gains, particularly in processing, storage and exchange of information. Domestic market and proximity relations can be on one side an advantage for ICT knowledge providers (vicinity of universities and

public labs, personal contacts between researchers, networking), on the other side disadvantage (lack of specific knowledge, IPR obstacles, not recognized country for high tech business);
- fourth, ICT favours the creation, innovation and growth of new products/services. In our cases the innovative firms took advantage of existing TKD which was not so advanced as in other W. European regions.

The interactions between FKD and TKD were not always explicitly pronounced due to the fact that our case studies included innovative firms which were not typical for the territory neither for the examined sector.

1.2. TKD and national policies

In Slovenia, public policies targeting the economic (and social) development have 4 main objectives and priorities: competitiveness and economic growth, efficient generation, flow and use of knowledge, efficient and cheaper state governance, welfare state and higher employment (see Framework of economic and social reforms for increasing the welfare in Slovenia, Government office for growth, Ljubljana 2006). The focus of our interest were development strategies, the implementing institutions and the targeted processes.

National governance has 3 different levels of institutional frameworks:

a) EU programmes (Cohesion Fund, Structural Funds, 7th Framework Programme) and other international programmes (Eureka);
b) National programmes (Development strategy of Slovenia, National mid term R&D programme 2006-2010), Framework of economic and social reforms, education and innovation policy);
c) Regional initiatives and schemes (strategy of regional development, strategy of spatial development).

Ad a) Slovenia was not very successful in drawing the financial means from the Cohesion fund and from Structural funds. (Official statement from the Commissioner Grybauskaite for the period May 2004-September 2007). Slovenia was above the average of the new member states regarding drawings from the Cohesion fund, i.e. 22%. Slovenia was also more successful in drawing the structural funds. In the same period 68% percent of available structural funds were used. This result puts Slovenia on 15th place among the EU25 and on the 2nd place among the new members. The managing authority for drawing the EU

funds is the Government Office for local self management and regional policy. The main beneficiaries of the EU funds in 2006 were: agriculture, (sub)regional initiatives, structural measures, administration, compensation for pre-accession state aid, etc.).

Our criticism of existing policies is oriented on numerous projects containing the construction of new buildings and purchase of new equipment at the stake of "soft" investment into human capital, new technologies and new business models.

Ad b) Slovenia's development strategy was adopted in 2005 and accompanied later with some instrumental documents and policy measures. (The Framework of economic and social reforms for increasing welfare, National R&D programme 2006-2010, foundation of Technological Agency, etc). It should be mentioned, that an important part of economic policies and policy measures (including with the investment into corresponding infrastructure) has been supported by the EU funds. The main co-ordinating authority for the implementation of the reforms is the governmental Office for Development, the responsible authority for the implementation of national R&D and educational programme is the Ministry for higher education, science and technology.

Ad c) Single programming document for the period 2004-2006 was the main basis for the conduct of the European cohesion policy in Slovenia. The main objectives of the use of cohesion fund during this period were faster economic growth, 4000 new jobs and balanced regional development, not allowing that the proportion between most developed and less developed regions would worsen. So far 12 statistical regions were taken into account.

Slovenia does not really have specific sectoral policies, but horizontal policies. The institutional framework in Slovenia is still evolving which can be ascribed to the search for the most efficient division of tasks between different ministries and strong influence of scientific lobby and less strong of export lobbies and SME business communities. The most important players are the Ministry of Economy, which was the main executive body responsible for setting up and implementing the STI policy until the end of 2004, and the Ministry for Higher Education, Science and Technology, which (together with the Agency for Technology) later took over most of the tasks in this field. The substantial interference of the politics in the economy is still a problem in Slovenia. The government is still an important owner and shareholder in many of the largest

companies and it therefore has a big influence on the business decision making process.

In the year 2000, the Ministry for information society was established. A great emphasis to the transition into the information society was given also in the Slovenian development strategy 2001-2006. In 2003, the Strategy of Slovenia in the information society was developed. This all seemed to show that the ICT sector is perceived as important by the Slovene government. However, the Ministry for information society was abolished in 2004 and some of its tasks were delegated to the Ministry of Economy, Ministry for higher education, science and technology and other ministries. Besides the fact, that the strategic ICT goals were not ambitious enough, it later also proved that sufficient funds had not been reserved for their implementation. Since Slovenia started loosing the position it had a decade ago regarding ICT, and lagged behind the most developed countries in this field, the critiques of the ICT policy started appearing. The main argument of those critiques is that while the ICT policy due to its importance plays a central role in the national development strategies of many countries, in Slovenia it has been taken over by certain lobbies. As a consequence, the development of the ICT sector and the information society as a whole has been neglected due to the promotion and protection of certain companies. While the situation regarding telecommunications is a bit better, the average expenditures per capita for the IT in the last three years had been three times lower, compared to the EU-15 member states. The most funding has been given to the e-government project, which has some indirect benefits for the citizens, but does not increase the availability and their interest for the new technologies, and even more important – it does not increase the e-business in the private sector.

1.3. TKD and research hypotheses

Generation and use of knowledge

According to three hypothetical types (regions focused on knowledge generation, regions focused on use of knowledge, regions with knowledge generation and use interplays) Slovenian TKD is in this paper assessed primarily as a »region« oriented towards creation of knowledge. Knowledge creation is now perceived as a complex, interactive and open ended process with a collective dimension. R&D and other knowledge institutions, human capital, skill formation, social capital and organizations are crucial to the knowledge creation. Due to the fact that majority of enlargement regions in Central and Eastern Europe have not preserved the linkages between

research and training institutions on one side and industrial activities on the other side they remained lagging behind or catching up regions. Slovenia is on the top of East European catching up regions (Summary innovation index in European innovation Scoreboard, 2007). Slovenia succeeded during the transition period (1991-2004) to retain relatively strong R&D capacities in the public sector (universities and public research institutes) and partly intramural R&D units in the business sector. TKD underwent severe systemic changes: from regional to national economy, radical privatisation from rigid planning system to viable market economy. The business enterprise sector witnessed the breakdown of the large socialist enterprises and privatisation process in this sector caused that intramural business R&D capacities in the 90s substantially downsized and slightly recovered in the middle of this decade. The co-operation between public R&D organizations and the private industry has been during the whole period quite weak and is one of the main reasons for low industrial value added, insufficient technological readiness and consequently lower competitiveness of Slovenian ICT sector.

Several arguments speak in favour of the thesis that Slovenian ICT TKD is more oriented towards the creation and generation of knowledge (analytic knowledge) and thus underestimating the role of knowledge diffusion and use of knowledge (synthetic and symbolic knowledge):

- overall investment in knowledge (higher education, R&D, software) in relative terms exceeds EU level (3%),
- Slovenian society exhibits relatively high expenditures for education and R&D (over 6% GDP),
- public R&D expenditures are still favouring basic science and non market driven research (analytical knowledge) through different financial schemes: programme financing, young researchers programme at universities and institutes, participation in EU framework programmes, Central and Eastern Europe programme etc.,
- prevailing share of programme financing in comparison with the project financing,
- relatively low public financing of technology and innovation via Technology agency in comparison with the public financing of scientific research via Agency for scientific research and other public institutions,
- low number of S&T graduates (76% relative to EU in 2005),
- lower level of ICT prioritisation and ICT investment (ICT investment in 2007 in Slovenia was 1,9% GDP compared to 2,7% GDP in EU average),
- insufficient exploitation of R&D investment and inappropriate specialisation of ICT innovation support network,
- fragmented research teams with subcritical mass of researchers and developers,

- low level of high tech exports including ICT products and services,
- low R&D internationalisation and insufficient inclusion into international value chains.

Mobility and anchoring of knowledge

The study and examination of 4 different types of knowledge anchoring (knowledge allocation, assimilation of regional knowledge, contextualisation of mobile knowledge, knowledge reciprocal learning) pointed out two modalities actual for Slovenian TKD. Firstly, assimilation of regional ICT knowledge and secondly, the contextualisation of mobile ICT knowledge.

Large Western ICT firms did not make any significant FDI investment into Slovenian economy in the last 2 decades due to the small domestic market and due to the relatively high labour costs of skilled labour in comparison with other East European countries (regions). The presence of the main multinational ICT companies in TKD has been limited mostly to distribution and training functions. However, such situation did not prevent substantial knowledge flows so that comparisons and rankings exhibit the process of diminishing the gap with the developed EU regions.

This situation created specific knowledge trajectory in Slovenia: strong reliance on domestically driven TKD and FKD and very important role of national R&D, technology and public procurement policies, related to ICT.

The following policy measures were set in force in the last years:

- promotion of innovation and knowledge infrastructure (development of new universities, technology centres, Centers of Excellence, technology networks, support for individual innovators),
- development of knowledge transfer system (specific measure of employing Young researchers in private industry),
- promotion of R&D co-operation among enterprises (technology platforms like ARTEMIS – embedded systems, NESSI, e-mobility) and identification of R&D priorities relevant for Slovenian economy (ICT, biotechnology, advanced materials et.),
- promotion of development cooperation and subsidies for industrial R&D projects and development of new technologies, products and services (strategic R&D projects),

- coordination of the international programme EUREKA, encompassing preparation and implementation of the public call for international industrial R&D projects as well as implementation of the EUROSTARS programme,
- participation in ERA-NET projects (e.g. MANUNET, CORNET, EraSME, COMPERA),
- participation in the establishment of cooperation with ESA – European space Agency,
- coordination of the activities related to the Investment Fund for new technologies in cooperation with Slovenian enterprise fund.

Mobility of knowledge is not enough fostered. For the sake of improving TKD and FKD better conditions for immigration of foreign ICT experts, scholars and students should be welcome.

Distance-proximity of knowledge sources

There are no uniform and simple answers to the question about the geographical and spatial sources of knowledge in ICT sector in Slovenia. Due to the fact that ICT is more market driven than science driven (Cooke, 2004) we have examined the main sources of knowledge in academic organizations (universities, research institutes) and in the interviewed business firms and their associations. Our findings confirm that the main sources of ICT learning process are predominantly locally based in domestic high education and research institutions combined with the different long distanced international sources (foreign universities, head and branch offices of multinational companies, conferences, exhibitions, workshops).

Knowledge institutions (Faculty for Electrotechnics and Faculty for Computer science and Informatics University of Ljubljana and Faculty for electrical engineering and computer science - University of Maribor) are the main domestic sources of knowledge. The new academic centres (in Novo mesto, Celje and in Nova Gorica) are emerging in the last few years. Centres of excellence and technology networks associated and strongly linked with 2 main universities have in the last years gained importance. CoE ICT in Ljubljana established partnership between academic institutions and business organizations by trying to form and integrate technical, applicable, innovation and research excellence in the broader multidisciplinary field of information and communication technologies (different areas of activities: multimedia, mobile communication, e-business, e-government, IP services, wireless communications, etc).

By connecting and networking the critical mass of experts and knowledge CoE ICT is directed towards joint integrated projects. The main strength and potential of CoE ICT is new organization and conduct of research projects. CoE ICT focuses on generation and distribution of knowledge and on investment in intellectual capital enabling new ways of partnership better adapted to the challenges of present market needs and distant market opportunities.

Important domestic knowledge sources are also 2 technology networks (ICT and process controlling) and numerous technology centres located in the whole Slovenian territory.

Multinational companies (IBM, Apple, Sisco, Microsoft, Ericsson) and affiliated training institutions (Mercuri) are also important knowledge sources. It seems that cross-border cooperation (for example with the neighbouring Graz in Styria and mid distanced Muenchen in Bayern offers new, so far not enough exploited opportunities for the transfer and exchange of ICT knowledge.

1.3.2. Confrontation to specific research hypothesis

The cooperation between science (universities, research institutes) and industry seems to be one of the most critical issues in enhancing the TKD and consequently the FKD in Slovenia and supposedly also in other CEE post communist regions. The public R&D sector has not undergone such radical changes (privatization, restructuring, downsizing, new business and governance models) as business enterprise sector. The main reasons for weak cooperation between two spheres are huge differences regarding the motivation and the missions of the involved institutions. The private business sector is on the basis of market pressures motivated for generation and use of new knowledge, innovation culture, networking, new management skills and for public-private partnership agreements. The motives for S-I cooperation in the business sector are the following: additional scope of pre-competitive research, access to R&D infrastructure at universities, identification of financing of research projects, access to theoretical expertise, improvement of local development, improvement of intramural R&D potentials etc.

On the other side, university scholars as public servants are primarily interested in teaching process, they are not specially motivated for new IT knowledge, for specialised R&D, for applied research and technological and non-technological innovation. Their motives for S-I co-operation would primarily be in gaining additional financial funds, to enrich the missions of their institutions, to obtain practical knowledge for socially

relevant research problems. Only minor share of scholars care for better employment chances for their students.

The higher degree of S-I cooperation can be achieved through formalisation of private-public partnerships, introduction of special incentive schemes for scholars and researchers in the public sector, change of curricula and habilitation criteria in public knowledge institutions, by higher attention to IPR at both universities and firms, by mobility schemes for professors and students, awareness campaigns for employing researchers in the business enterprise sector etc.

1.4. a Understanding the related FKDs

1.4.1. General synthesis of the FKD and its relation to the TKD

The first selected case is the development of the product SI3000 Call Server, which is a central and most innovative part of the product family SI3000 Control Plane. This product family is designed for various types of telecommunications operators and service providers and is prepared for the convergence of fixed and mobile networks, which is a key telecommunication trend in recent years. The product was developed and produced by the firm Iskratel, which is one of the most innovative telecommunication firms in Slovenia.

The first reason for the selection of this case was that the firm and the product itself are good examples of successful cooperation with the public research sector. SI3000 CS was developed in cooperation with University of Ljubljana - Faculty of electrical engineering and University of Maribor - Faculty of electrical engineering and computer science. The University research teams were included practically from the beginning. The knowledge flew into both directions, the synergy was good and the cooperation was beneficial for both sides.

The reason for the selection of this case was also that the case and therefore also the studied knowledge dynamics, far surpasses the regional borders development wise as well as market wise speaking. Not only proximate, but also very distant sources of knowledge were tracked and used. For example, the first concept of the product was presented on the Geneva telecommunication fair, where a connection with Intel was established. Intel not only became the supplier, but as a partner also provided some crucial knowledge for the development of the product. Further on, exhaustive testing of the product was made not only in cooperation with a client on a regional market, but also in a Russian technopark, where also some of the first customers were acquired.

Moreover, through Iskratel's joint-venture company in Russia (IskraUralTEL) also certain R&D knowledge was anchored not only from the R&D team employed there, but also their connections with the Russian public research sector.

To achieve that kind of successful knowledge dynamics, the firm needs to realise its importance and know how to stimulate it. In Iskratel much effort is put into identifying the needs for certain new knowledge, training the employees and motivating them to share their knowledge with others. Innovativeness and team work are part of the firm's culture.

While there is a general problem of cooperation between public and private research sector, this case demonstrates, that the cooperation can work out very well, if the interest and motivation exists on both sides. Still, the problem, that the academic measures of success do not appreciate the commercial applications of scientific knowledge enough, and therefore do not motivate the scientists for this kind of work, remains.

1.4.2. Confrontation to EURODITE research hypothesis

Although several similarities can be found between the studied FKD and the general characteristics of the TKD, the confrontation of the research hypothesis demonstrates several differences. Since the studied FKD presents a good practice, it is of course in many views better then the general KD in the region.

The studied FKD presents a successful combination of knowledge creation as well as the knowledge use. The case also demonstrates the capability of knowledge anchoring, which is not the characteristic of the TKD, but it is the capability of the best firms. When identifying and using different sources of knowledge, Iskratel is by no means limited by distance. While the core of the knowledge base is indeed internal and located within the region, the FKD study demonstrates that some crucial sources of knowledge can be found far beyond the regional and national borders.

The application of the categories of knowledge, which were theoretically defined in the previous Eurodite WPs, to the FKD findings also enables some interesting conclusions. The first finding is, that in the ICT sector the symbolic knowledge seems to be not that important compared to other types of knowledge. The FKD mostly evolves around analytical knowledge, which is acquired through the cooperation with the Universities, and synthetic knowledge, which is mostly internal. While most of the technical knowledge is codified, also tacit knowledge plays an important role. Tacit is the knowledge about how to combine all different information into a profitable innovation.

Often also the clients can not express their needs and desires, therefore the firm needs to have the capability to codify this information in order to transfer it within the firm and apply it to the product. In the studied FKD exploration, examination and exploitation of knowledge were of course all important, however, the examination phase stands out, since it was very long compared to the average FKD. In the examination phase which was carried out in the Russian technopark, analytical knowledge was crucial, while in the tests performed at the client and also in the exploitation phase, synthetic knowledge was more important.

1.4. b Understanding the related FKDs

1.4.1. General synthesis of the FKD and its relation to the TKD

The second studied case is the development of the product Frontman by Spica International (a small, innovative firm, participating in the Process control technology network). Frontman is a product which today enables much more than just tracking of the products or collecting orders on field. It can also be used for merchandising, gathering information about competitive products, carrying out surveys, etc. It is connected with the client's business support system (for example Navision or SAP), and transfers all the gathered information straight to it, and also receives feedback, which enables instant decisions on the field. It can also be integrated with many different peripheral devices (such as printers, pay terminals, meters…) in order to best fit the clients specific needs.

The studied case is not only about the development of a new product, but also about the shift from the technology suppliers for other firms to the end consumer market. The decision for such a change was based on the internal strategic knowledge and also external information acquired with monitoring of the technological and economic environment.

The beginnings of this product date back into the year 2000, when the most basic version of the product was developed, using the simple technology available at the time. For the development of the product, besides the technological knowledge, which was already possessed by the firm's human resources, the most important was the absorption of information from the clients about their needs and desires, for which a very close relationship with them was necessary. The technical knowledge base in the firm is constantly upgraded by training and also by recruiting of young experts, for which the cooperation with the University is very helpful. As the technology advanced, so did the product. In 2005, as a network project, Frontman was successfully integrated with

SAP, which is one of the most important business support software's. The project provided a more standardised solution for food and drink industry and opened many new opportunities.

Besides the University and clients, the close relationship with the supplier/partner Symbol needs to be emphasized. Symbol provided Spica with a lot of different knowledge, most importantly with know-how about its multinational clients and early access to the hardware. Pretty particular is also the relationship of Spica with some of its competitors, which in fact became partners. Their relationship is based mostly on trust and is about sharing the excessive work when one of them is lacking time or capacities.

The company soon transcended the national borders, not only in terms of penetrating foreign markets, but also by identifying and anchoring R&D knowledge abroad. In 2007, part of the Frontman's R&D was transferred to Serbia and the firm's vision is to establish partner regional competency centres according to the specialised knowledge available in different regions.

1.4.2. Confrontation to EURODITE research hypothesis

Similarly as the first studied FKD, also the second selected knowledge biography can serve as an example of good knowledge dynamics compared to an average firm in the ICT sector in region and can therefore not always be related to the characteristics of the TKD. The studied knowledge biography demonstrates a case of good cooperation with many different actors, including the public research sector. Again, the studied case includes the creation as well as the use of knowledge, or a successful combination of both. Unlike most of the firms in the region, Spica is able to anchor the knowledge from other regions and also has future plans which should enable even better knowledge anchoring. To ensure good knowledge dynamics with other sister firms or competency centres, the firm's employees and their knowledge of course also need to be mobile. While a lot of KD evolves around the proximate sources of knowledge (Universities and development partners in the region), recently distant sources are gaining importance (Symbol, sister firms in other regions).

Also this case shows that in the ICT sector, the symbolic knowledge is not that important in any of the phases, except when it comes to interaction with dealers and customers. Synthetic knowledge played the most important role in this case, specially in the exploration and examination phase. Most of this knowledge was provided by the internal R&D team, and the rest by partners. In the examination phase also the clients'

knowledge in important. However, clients are not always aware of or cannot express their needs, and do not know that a certain product can meet those needs. This is what makes a close relationship with the clients very important, and the firm also needs the capability to define and codify those needs in order to be able to transfer them internally, and apply new solutions to the product. While most of the technical knowledge is (or can be) codified, the knowledge about how to combine different information into a profitable product is not easy to codify.

1.4. c Understanding the related FKDs

1.4.3. General synthesis of the FKD and its relation to the TKD

In the last selected case we study the product BeeSmart, developed by the firm Smart Com. BeeSmart started out as a complete, interactive middleware solution for IPTV systems. However, while paying attention to the market and cultural knowledge context, a team of employees realised, that consumers are not interested in the specific products/services anymore, but demand complete, integrated solutions. Since 2006, when the development of the product started, it grew into much more. Today, BeeSmart is seen more as a platform or an open system, which enables the integration of all different kinds of technologies that serve their clients specific needs, and therefore offers practically endless possibilities for future development. The product is of central importance for the company, since it is the product with most potential on the international markets and can also open opportunities there for other products and services.

BeeSmart was developed mostly by the firm's internal actors by combining, upgrading, and integrating their existing knowledge. The culture of the firm promotes learning and innovation and its employees are very motivated by their own interest and curiosity to acquire new knowledge and participate with their own ideas for new product or improvements. Also the transfer of knowledge within the firm is very good.

Besides the internal knowledge base, also external knowledge, which was found at different sources, was included in the development process. Most of the partners come from more proximate locations, mostly within the same region. In the development of the Iris modification, the Institute for rehabilitation and the Faculty of electrotechnics, Ljubljana were included. The firm has been cooperating with the Faculty on many different levels for long years and the knowledge is transferred in both ways.

However, some of the acquired knowledge flew into the company from more distant locations. The monitoring of the environment for new developments enables the awareness and anchoring of relevant knowledge from worldwide locations. To anchor that knowledge, it is also necessary for the employees to be very mobile and participate in conferences and trainings wherever a specific (technical or business) knowledge is available, regardless the distance. Much of the technical knowledge is provided also by the international suppliers. Since the only guide for developing modifications is the added value for the clients, besides the R&D knowledge, the knowledge dynamics with the clients is most important. Since the product soon outgrew the regional market, so did the transfer of knowledge with the clients.

1.4.4. Confrontation to EURODITE research hypothesis

As can be seen from the synthesis, the third studied FKD, similarly as the first two, also presents a case, which in many views stands out in the studied TKD. For the successful development and commercialisation of the product, the firm had to generate its own knowledge (mostly R&D) but also use as much external knowledge as possible (competition, customers, partners…) to enrich the internal knowledge base. The firm was able to anchor knowledge from proximate as well as distant sources of knowledge. While most of the R&D partners come from the same regions, the suppliers are international and offer a lot of technical knowledge. To be able to access it, the employees need to be mobile. As the firm's market transcended the national borders, the knowledge from the international customers and agents also became very important.

In the third FKD the synthetic knowledge was most important in all development phases. In this case, however, effort has been put into the protection of the brand BeeSmart, which means that also symbolic knowledge is recognised as important by the firm. A minor part of the used knowledge was analytical and it was contributed by the University for the Iris modification. Again, the technical knowledge was codified, while some of the business and combinatorial knowledge was also tacit.

2. POSSIBLE FUTURE STAKES ABOUT THE TKDs IN THEIR BROADER CONTEXT

2.1. The KDs and sectoral dynamics

As a consequence of protected and oligopolistic structure, the ICT sector in Slovenia developed with the average growth rates in the period 1992-2004. The share of ICT firms in the total revenues of the business enterprise sector increased from 4,5 to 5,5%, the share in value added from 3,8 to 5,6%, in employment from 3,3 to 4,5% and in exports from 1,1 to 2,6%. ICT firms have thus increased their shares in the total economy but the growth rates in other sectors (trade, financial intermediation, business services) were much higher. With the exception of the joint venture between Siemens and Iskratel (in telecommunication business) the knowledge base was oriented on domestic institutions within the country (universities, research institutes, industrial R&D units). In ICT sector there were no significant inward FDIs. Unfriendly business climate (long bureaucratic procedures for starting business, high taxes, shortage of highly skilled engineers, state owned enterprises, absence of venture capital) caused that a relatively small number of innovative SMEs emerged. An additional problem was caused by the high prices of access to the telecommunication infrastructure. For too long, the infrastructure for fixed and mobile telephony was based on obsolete technologies run by state owned Telekom and daughter companies Mobitel, Siol. The National environment for ICT in Slovenia is by international standards ranked on 42nd place, what means below other indicators of national competitiveness: macroeconomic performance, infrastructure, business management (WEF: Global IT Competitiveness Report, 2008/2009).

The foundation of two technology networks in 2004 (ICT - comprising all important stakeholders and process controlling network) is an important step towards:

- a strategy of growth aiming to increase the revenues and value added of members of the network, especially for SMEs,
- an increase of the efficiency of R&D activities in joint projects (technological platforms, satellite road pricing, interoperability labs, etc.),
- enabling the possibilities for technological breakthroughs,
- strengthening the knowledge base in ICT by internationalisation common R&D projects,
- formation of an integrated ICT area with cross border co-operation.

Our hypothesis of the ICT TKD in Slovenia is that the shift from the prevailing concept of generation of knowledge towards the use of knowledge is needed. Privatisation of the main operators and opening of the R&D system in ICT means, that distant specialised knowledge will be demanded. The shortage of domestic ICT experts is the constraining factor in the growth process. That is why we expect a higher mobility of the skilled personnel (the question of cross border mobility). In order to verify these hypotheses, the in-depth interviews were made in knowledge institutions (universities, research and technology agencies), large enterprises (Iskratel, Telekom), medium sized firms (Adacta, Smart-com, Inea) and small companies (Špica International).

The service sector contributes most to the value added. It is expected that its share is going to increase even further, even though Slovenia is still behind the developed economies according to the share of services in the GDP. On the other hand, the shares of agriculture, construction and manufacturing in GDP are decreasing. The manufacturing industry is still the most important sector in terms of exports. Moreover, productivity (measured as a value added per employed) increased most in manufacturing activities.

The commodity structure of Slovenia's exports reflects the insufficient competitiveness of the economy, weak sustainability of economic growth and low technological level of the manufacturing industries and services sector. The exports measured by technological intensity and the shares of business R&D expenditures (0.9% GDP) are stagnating.

The share of high tech products (pharmaceuticals, medical equipment, scientific instruments, computer and communication equipment) was quite low (16,0%) compared to EU average (27,9%) and to the average of the new member states (19,4%) in 2005, and has shown stagnating trend. The majority of Slovenian exports are concentrated in middle tech products (automotive sector, machinery and equipment, rubber and plastic products, electric apparatus and appliances etc.). The share of low tech products in Slovenian manufacturing (paper and board, furniture, textiles, footwear, metal products etc.) is constantly decreasing, and represented 25,8% of the total exports of goods in 2005 (compared to 22,3% in EU25 and 15,7% in EU10). It is surprising that despite relatively high labour costs in Slovenia, the share of labour intensive exports is still high (17%).

Diversification of export flows and increases in the volume of exports calls for introduction of improved production programs and product and process innovations. Moreover, future investments in human capital and technological development would increase labour productivity and strengthen the international competitiveness.

2.2. The relations to other places, to other geographical scales and within a more mobile world

TKD in Slovenia are very much linked, impacted and interconnected with the countries and regions inside of EU. Before gaining independence in 1991 most of the trade, capital, people and knowledge flows were oriented in the regions and republics of former Yugoslavia. The loss of former Yugoslav market, EU approximation process and EU accession caused that foreign economic relations concentrated in the EU countries and neighbouring regions. The cooperation with France is concentrated in automotive sector. More than 70 percent of trade and capital flows is oriented in West European geographical territories. Due to proximity and fast improvement in physical, scientific and technological infrastructure there is a scope for the intensification of the TKD and economic relations also with other more distant regions in Italy, Austria Germany and Mediterranean regions.

From the standpoint of complementarity in economic and social development special attention should be paid to the intensification of knowledge flows with Hungary, Croatia and the countries and regions of Western Balkans (Bosnia and Herzegovina, Serbia, Macedonia, Kosovo). The labour, cultural and academic mobility schemes are the levers for the encouragement and intensification of transreg and cross border co-operation.

Slovenia's economic policy with neighbouring less developed regions is oriented in expansion of foreign trade (export of services), in outward FDIs, in scientific and technological co-operation, improvement of transport infrastructure and academic (professors and students) mobility schemes.

Slovenia's TKD relations with non-European countries and regions are limited due to the small critical mass in human capital, limited quantities of potential delivery of goods and high transportation costs. However, numerous bilateral and multilateral agreements, traditional trade and knowledge institutions relations with some countries (USA and Russia) give the opportunities for market niche strategies. The academic exchange of knowledge (professors and students mobility) with USA is of extreme importance due to the high quality of American top universities. On the other side, the case study (FKD2 in ICT business) gives the proof for the successful transfer of knowledge even in very distant places and locations.

Macroeconomic performance is facing many structural unbalances, which indicate the stagnation of country's international competitiveness, diminish the prospects of smooth transition into a knowledge based society and call for implementation of economic and social reforms. Key problems, which are hindering the international competitiveness and the shift to the knowledge based society are connected with the restructuring of public finance, educational system, health care, pension and R&D system, flexibilisation of labour market, liberalisation of public utilities and privatisation of state property. The following chapter is focused on R&D, education, technological development and innovation as the main determinants of TKD and FKD.

2.3. Suggested adaptation of Slovenian policies

In Slovenia - as well as in other Central and Eastern European regions - national policy makers have strong impact on TKD in ICT sectors. It seems that in the context of »triple helix« institutional set up (government, business, academia) there is a need for the implementation of coherent and long term oriented policies. These policies mix should include not only innovation and R&D but also social, environmental and educational issues.

Despite the establishment of relatively abundant range of intermediary supporting institutions (regional development and technology agencies, technology parks and technology networks, incubators, center of excellence, innovation relay center, transfer technology offices) we did not find its counterpart in implementation of appropriate policies, action plans and operational documents.

The broad spectrum of relevant policies should improve in many ways not enough reformed economic and social environment and rigid science and education system. Among these areas the provision of a competitive microeconomic environment, an appropriate regulatory framework, competitiveness measures, reform of the rigid public educational and R&D system and provision of coherent innovation policies seem to be the most important policy measures.

The market environment for providing ICT and related services is still not enough competitive compared to the regions in Western Europe. Oligopolistic market structure prevent prices from falling and improvements in quality of products and services. Appropriate regulation, easier entry to the market, and flexible labor market, fiercer competition among producers and service providers could lead to lower prices, higher efficiency and productivity.

The reform of the public universities and research institutes is one of the key issues in order to improve the TKD. The reforms have generally been slow and moderate in scope in most post communist countries and regions. The status and role of the public universities and research institutes should be redefined in order to provide the appropriate graduate and postgraduate skills and knowledge, to intensify rather weak co-operation with the private business sector, to upgrade scientific excellence, to increase the motivation for market driven (applied) research, to increase the internal and external mobility of professors and students, to increase the capability of public knowledge institutions to enter into proximate and distant networks, to abolish the imbalance between S&T graduates and graduates in other fields, to improve monitoring and evaluation systems, to use domestic and EU resources for information society and KIBS development.

Limited human resources (the small number of graduates in the field of informatics and engineering) seem to be one of the main constraining factors for further development of ICT in Slovenia. The increase of the enrolment of young generation (and particularly female students) is only one part of the solution for the shortage of skilled people in the sector. Because of the emerging brain drain the favourable scholarship schemes and immigration policy should attract also the students and experts from abroad.

The low and inefficient R&D expenditures are considered as the main drawbacks in the national innovation and science system. The trends in overall R&D expenditures in GDP during the period 2001-2005 were stagnating. This indicator for 2008 is 1,66%, which is slightly higher than in the previous year but lower than in the period 2001-2003 and means 0,36 percentage points behind the EU average. BERD represent 0,83% of GDP which is far behind the Barcelona target for 2010 (2% GDP). Two thirds of total number of researchers are working in the public sector (universities and public research institutes) while this figure for EU25 is one third. Only 30% of all enterprises are innovative in the sense of generating new or improved products or services. SMEs are the least innovating firms (only 13% of SMEs are innovating according to CIS3). Low level of co-operation between public R&D institutions and the private business sector calls for an appropriate mix of measures fostering such collaboration, including the government support for applied research and specific financial instruments (venture capital funds, funding start-ups and spin-off companies, the employment of young researchers and scientists in the private business sector, etc).

Science, R&D and educational systems in Slovenia are more oriented into production and generation of knowledge than in its diffusion. Total public expenditures on education as a percentage of GDP have been in the period 2000-2003 quite stable

(around 6%) what put Slovenia above the EU25 average. Excellent results on EU level are noticed in the completion of upper-secondary education. On the other side, there are many disadvantages of the secondary and tertiary educational system (low number of graduates in mathematics, science and technology). Despite the fact that the number of graduates in S&T has increased in 2005, and reached the share of 18,4% in the total number of graduates, Slovenia is still lagging behind the corresponding number in EU (23,6%). The mismatch exists also in the proportion of women students in S&T (25% in Slovenia compared to 30,8% in EU 25 in 2005).

The above mentioned indicators of educational system call for a reform of the educational system by opening of the system to the wider world, by the creation of conditions for founding new faculties, to create incentives for the international excellence of higher educational institutions, to increase the international mobility of professors and students, to improve the quality of curricula in accordance with Bologna process, to increase the quality of vocational training and life long learning, to diminish early school leaving etc. The fair competition should be introduced between public and private educational institutions.

2.4. Synthetic findings about gender issues

ICT sector (either in manufacturing or in services) has traditionally low female employment. This is not as a result of discrimination policies but rather as a result of traditional behaviour attitudes and as a result of very low tertiary enrolment in natural and engineering sciences. If we look at the enrolment and graduation of women in Ljubljana Faculty for Electrotechnics the figure is between 3% and 5%. Somehow better figures (from 5 to 10%) can be found for Faculty for Computer Sciences and Informatics at the same Ljubljana University.

There is a shortage of computer specialists and highly skilled ICT engineers in the labour market. So far no specific policy campaign and policy measures for fostering ICT jobs for male/female have been launched. We could think about ICT awareness programmes at secondary level, special scholarship and training programmes for S&T and ICT students, attracting foreign skilled engineers and researchers.

During the study of TKD and knowledge biographies in Slovenian ICT sector we did not encounter any explicit gender segregation or any gender discrimination polices. This can be confirmed at the national and at the firm level. This is to great extent the consequence of the very positive legacy from the former socialist system and very gradualistic transition into capitalist society. One important characteristic of Slovenian

labour market is that there is very small gender differentiation in wages. Women in the same posts have on average 6,9% lower wages than men. This is according to Eurofound one of the lowest gender differentiations in EU 27. The merit of various civil society institutions (Slovenian Consumer Association, Women Entrepreneurship organisation, Council for equal opportunities, different social clubs and civil society institutions) in the last decade is that the role of women in socio-economic life has increased.

By examining enrolment figures at universities and other higher educational institutions we found that women had certain study preferences in the social sciences (law, economy, sociology, communicology), medicine and humanities and less interest in hard sciences. Traditionally, the study of electro and mechanical engineering, computer science and informatics is the field where women students are in great minority. There is a certain positive inscription trend in computer sciences in the last years where the percentage of women student tends to reach 20% of total enrolment. This can be felt in the firms when looking into the share of employed women and in the percentage of higher educated women. On the other side, a growing share of women white collar workers postpone maternity in favour of making professional career.

It was noticed through interviews that women prioritise symbolic knowledge (in relation to codified or synthetic knowledge) and that they have very positive role in the multidisciplinary teams and collaboration networks, particularly in R&D departments.

It should be stressed that gender diversity is not encouraged in the business community, the situation is much better in the academic sphere.

As regards gender knowledge context it seems that different national policy documents try to diminish huge imbalances in top positions in political, economic and social life where men are privileged. The implementation of these documents is weak because the political and business networks are mostly led and dominated by men. Political parties have decisive role in public administration and in state controlled enterprises.

We did not find any significant differences or discrimination in mobility patterns regarding the gender issue. The care for children and the organization of “kindergardens” hamper young women to take greater participation in the TKD and FKD.

3. GENERAL CONCLUSIONS

Slovenia is a small economy which has been considered as one region also in the NUTS/1 classification in the past period. To enable a better comparison with other studied regions and since the process of regionalisation of the country is still not finished, we considered Slovenia as one region in this study.

Slovenia has traditionally had a more open economy than the rest of the transition CEE countries, which resulted also in more export and progress-oriented companies and smoothed the transition process and the loss of markets after gaining the countries independency. It boasted relatively stable growth of GDP and ranked among the countries with the lowest degree of risk. Despite good macroeconomic performance (above average growth rates of GDP and employment, relatively low foreign debt, increasing human capital, low level of poverty and social exclusion, etc.) there are many structural imbalances which indicate on the stagnation of country's international competitiveness, diminish the prospects of the smooth transition into knowledge based society and call for implementation of economic and social reforms. Key problems which are hindering the international competitiveness and shift to the knowledge based society, are connected with the restructuring of public finance, educational, health care, pension and R&D system, flexibilisation of labour market, liberalisation of public utilities and privatisation of state property. The share of high tech products is low compared to the EU and the majority of exports are concentrated on middle tech products. While the service sector contributes most to the value added, also the share of services in the GDP is lower, compared to developed economies. Since the ICT sector produces twice as high value added per employee as the rest of the economy and is also strategically very important for the countries transition into knowledge economy, our study of the TKDs and FKDs is focused on the ICT sector.

In the 90s, Slovenia had good chances to close the gap with the leading European countries in the ICT field. The market was relatively developed and the infrastructure was established, while the people were very prone to technological novelties. However, due to absence of structural reforms and due to not enough ambitious strategic ICT goals and under funding provided for their implementation, in the last ten years Slovenia lagged behind the most developed countries, specially in the field of IT. In the field of telecommunications, most of the indicators still rank Slovenia in or above the EU average. One of the main problems is the big influence of lobbies with particular interests on the ICT policy and a lack of a large scale competition, despite recent liberalization of the telecommunications market. Several institutions were developed in order to improve the knowledge dynamics in the ICT sector, such as the Association for

ICT, Institute for Telecommunications and the ICT technological network. Despite different bridging institutions, the strong feeling of competition among different companies presents a huge barrier for the knowledge dynamics, since it makes some of the major companies reluctant to reveal any information. Besides that, one of the major problems in the ICT sector is human resource. The enrolment into the faculties and programmes, related to the ICT field, is too low to meet the needs for the technological breakthrough. Furthermore, the universities in Slovenia are quite rigid and adapt to new economically relevant knowledge demands quite slowly.

3.1. Combinatorial versus cumulative KDs, territorial relations, mobility and anchoring

Positive developments in the last decade relating to ICT and structural changes can be ascribed mainly to cumulative KD. This was based on accumulation of knowledge generated by domestic players (companies, universities and research institutes) and distant knowledge sources (multinationals, conferences). The main positive change was a gradual shift from manufacturing to services, and this has narrowed the gap in structural terms between Slovenia and more developed EU regions. The macroeconomic environment enabled to increase the investment into ICT, gross fixed capital formation and increased business R&D investment. % of all enterprises that introduced new products for the market was in the manufacturing of electrical and optical equipment, computer and related activities higher than in the whole industry. The same is true for the % of enterprises with R&D unit, for the share of innovation expenditures and SMEs innovation co-operation. R&D and education are crucially interrelated in creating new technologies and generating absorptive capacity for ICT adoption and ensuring its wide use. In the second half of 90s export of computer and communication services increased indicating that ICT services were relatively well developed and could be regarded as a result of cumulative learning process.

Several drawbacks and deficiencies in the promotion and implementation of ICT (including related industries) indicate that combinatorial KD has been less practiced and paid less attention. ICT sector is still quite fragmented, with the main orientation of the firms towards the domestic market. ICT prioritisation is not sufficiently supported by government and intermediary bridging institutions. Many companies are faced with the lack of personnel combining ICT and managerial expertise. The general education level of the labour force in Slovenia is not sufficiently high to guarantee a smooth transition to the knowledge economy. The situation is worsened by out-dated educational system, programmes and rigidities in the university system. We are witnessing low, reverse mobility of scholars and tacit knowledge from the business sector to the public or private

academic institutions. High education programme (curricula) reforms in the direction of more interdisciplinary studies which should ease the transition into knowledge based society, have been hindered. (Turlea G., M. Bogdanovicz, 2006). Looking at current situation, not many stakeholders are aware of the gap between the existing quality of human resources and the need to upgrade their knowledge and skills for a transition into knowledge society. The planned reforms (some are already underway) of the educational system stress as very important those topics which are highly relevant for the ICT: special attention to promotion of tertiary education in natural and technical sciences (and particularly in post graduate studies in informatics and computer science), increase of interdisciplinarity in education content and active support to life-long learning.

There is a danger that the complex and multiscalar character of ICT and information society will be in the future overlooked and that interlinkages between the different actors involved in the combinatorial KD will not be sufficiently taken into account. Presently, the responsibilities and functions of former Ministry for information are split into 3 ministries. Coordination of different policies has been always one of the key problems. Policies promoted by different ministries and the programmes available focus more on individual citizens (G2C; e-services at the government and local community level; different forms of e-learning) than on ICT applications in the business sector. This reflects the lack of integrative, combinatorial approach to ICT.

3.2. Specific conclusions for Slovenia

Slovenia has in the period 1991-2008 undergone economic and social transformation from closed region with rigid planned economy in the former Yugoslavia to open market economy within the EU. According to ICT network readiness index (WEF, 2007 - 2008) it was ranked amongst the most successful Central and Eastern European countries (regions) regarding the production and use of ICT. Slovenia's ranking was 30th among 127 countries in the year 2008. Only Estonia and Hungary were among new EU member states placed on higher positions regarding the ICT networked readiness.

Such progress was made on the basis of increase of resources devoted to the production, diffusion, transfer and management of ICT knowledge. If the favourable international trends continued (before the break of financial and economic crisis in 2008) Slovenia would under "ceteris paribus" conditions need about 10 years to catch up with the EU-15. The favourable trend was hindered by the profound social crisis.

Our research shows that for the enhancement of TKD and FKD the radical restructuring of the society and economy towards technological and non-technological innovations and knowledge based activities, is needed. Given the present slowdown of economic growth the radical structural adjustment in the future is the must for all stakeholders: government, business enterprise and knowledge institutions. Changes in economic structure imply activities with higher value added per employee, higher internationalisation of the economy through R&D, foreign direct investment and formation of strategic alliances, continuation of transparent privatisation process, improving the quality and efficiency of the tertiary education and R&D investment. The restructuring of general government expenditures (together with public pension and heath security funds) should contribute to decrease the public consumption to viable 38- 40% of GDP. The effective conduct of competition policy is particularly important for ICT TKD. It is required very strict governance and monitoring system in the financial sector (banking and insurance) because of mismanagement and numerous bad business practices in the past. The recovery of macroeconomic stability remains the most important objective of economic policy in the future – in the short run, mainly in the area of ensuring price stability and maintaining the stable fiscal position and in the medium run, ensuring the long term viability of public finance.

At micro level the application of new business models and management systems, enhanced and more efficient R&D spending, application of symbolic knowledge, new product strategies in areas like friendly environment, eco technologies and energy less intensive systems, is urgently needed.

Main future challenges for Slovenia's TKD in ICT are connected with the innovation and R&D policy issues: better exploitation of R&D, less fragmented R&D investment, research priority identification, product and service specialisation, increase the number of ICT professionals, R&D internationalization, integration of numerous stakeholders in the process of consensus building and conducting coherent policy mix (R&D, innovation, education, finance).

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