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Do We Have Enough ICT Specialists in the Period of eDependency?

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Abstract:

After overwhelming the crisis period turbulent economic environment is typical for present days as well as permanent increasing dependability of all our activities on information and communication technology (ICT). General basis for using ICT in economy is sufficient number of well-qualified specialists with university education background, especially ICT professionals. In this contribution two research questions are formulated. Answers to them evaluate and compare real starting positions of Slovenia and the Czech Republic from the point of view of number of university graduates (with partially accent on ICT education) as driving potential in the economy. Some recommendations, proposals and forecasts for further development of education system in Slovenia and the Czech Republic are presented at the end of this contribution.

Keywords: human resources, information technology, number of students, graduates

1 Introduction

Information and communication technology (ICT) has become ubiquitous in the globalised economy. Integration of it into every day's life reasoned our permanently increasing dependency on it. Massive investments into ICT in the last twenty years started economic growth. Not everything has been so successful as expected (for example the dot com boom in 90s and its intensive reduction at the beginning of the 21 century) but years 2000-2008 can be characterized as nine years of continual and dynamic growth of investments into ICT with significant impact on the economic growth (Doucek, 2010; Doucek, 2010a). It can be exemplified by new goods and services offered on the market or by new channels for their distribution using ICT infrastructure – for example e-shops, e-marketplaces, cloud

computing, providing services through model „Software as a Service” etc. (OECD, 2008; Quiang et al., 2003; Carr, 2004).

The economic growth linked to ICT investments brings with it new requirements on human resources. We can see two main influences in the period of eDependency:

- increasing demand on ICT literacy by the whole population and
- growing need for ICT specialists disposing adequate skills and knowledge.

2 Research Questions

Because authors of this paper are working at the university, they began to address the issue of quantity and quality of educated ICT specialists a few years ago. Authors focused on quantity factor of ICT specialists in this paper. They put the following research questions:

RQ1: Does the number of undergraduate and graduate students correspond with the development of the population?

RQ2: Does tertiary education system in ICT-related study programs react on increasing dependency on ICT?

Our research questions in this paper are focused on quantitative characteristics of ICT labour market. Because we want to compare a situation in different countries, we can operate only with data provided by national and European statistical offices.

Answers to these research questions were examined for the Czech Republic and Slovenia with benchmarking to EU27.

3 Bases of the Research Questions

Although the global economic crisis was the reason for disinvestment into ICT in 2009 (OECD, 2010), McCormack (2010) expects that ICT will generate almost 5.8 million new jobs till year 2013. These new jobs will have to be saturated by adequately qualified ICT specialists. Parts of these new jobs will be saturated through new employees entering into the ICT sector. Differences among future scenarios of economic growth with impact on the gap between supply and demand of ICT specialists are shown on the Figure 1. Each line represents the gap between supply and demand of ICT specialists on the Figure 1.

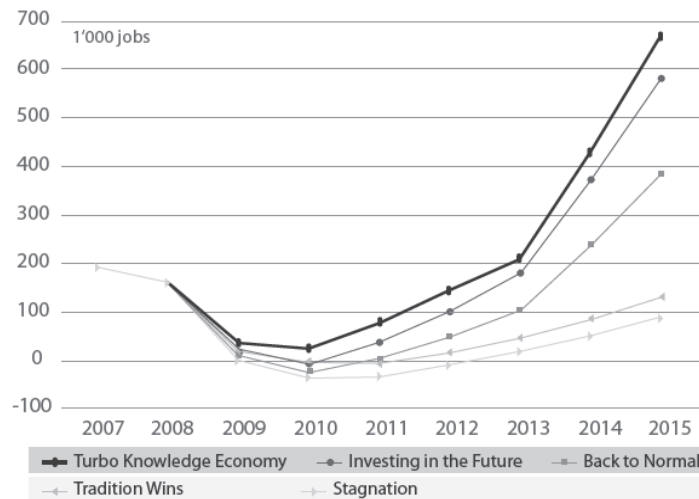


Figure 1: e-Skills Demand and Supply Gaps in the EU27 from 2007 to 2015 (McCormack, 2010)

The legend to Figure 1 is followed from (McCormack, 2010):

- **Turbo knowledge economy.** Take off in Europe, thanks to a virtuous circle of productivity and economic growth driven by widespread diffusion of ICT-based innovation.
- **Investing in the future.** Return to moderate growth, accompanied by acceleration of ICT investments and innovation.
- **Back to normal.** A return to the historical development trajectory experienced before the crisis, in terms of growth rates and ICT innovation.
- **Tradition wins.** After the crisis, export-driven recovery favours traditional industries, rather than high-tech and innovative industries, resulting in moderate economic growth with low ICT growth. Relocation of the ICT industry outside Europe accelerates.
- **Stagnation.** Very slow recovery accompanied by domestic protectionism in most important countries, discouraging innovation investment. The European socio-economic system struggles to keep up with emerging economies and tends to close itself off. Low ICT investments and growth in IT off-shoring leads to reduction in demand for e-skills and potentially over-supply.

McCormack (2010) also notes that countries have one of the last opportunities to make arrangements to prevent the lack of ICT specialists. In the case that they will not find solutions, they can expect difficulties in providing ICT services in the future.

The most important opportunity to change current trend and remove existing gaps that were shown in Figure 1 is the education. Our research deals with the tertiary education system in the Czech Republic and Slovenia with focusing on the education of ICT specialists.

4 Tertiary Education in Slovenia and the Czech Republic

The Czech Republic and Slovenia have started, keeping with Bologna declaration, transformation of their tertiary education systems in the year 2000. Both countries changed their systems to three levels presented by bachelor (undergraduate), master (graduate) and doctorate level of study. Nowadays there are 22 universities, 4 art academies and 46 private higher education institutions (HEIs) in the Czech Republic (MSMT, 2010). There are 4

universities, 3 art academies or professional colleges and 10 private HEIs in the Slovenia (MES, 2010). We do not want to make comparison of these numbers, because both countries have different attributes, for example population, area, culture etc. The Czech Republic has 3,9 times larger area than the Slovenia and total population is even 5 times greater (see Table 1).

Table 1: Basic Characteristics of Slovenia and the Czech Republic, (Eurostat, 2010a)

	Total Area (km²)	Total Population	Number of Universities
Slovenia	20 273	2 046 976	17
Czech Republic	78 866	10 506 813	72
Ratio CZE/SI	3,9	5,1	4,2

The changes in number of students in tertiary education system and especially the numbers of students in ICT-related study program compared with the size of population are important for economic growth and represent innovation potential of each country. We were convinced about this fact several years ago. It was the reason that we have started a research project at the Faculty of Informatics and Statistics, University of Economics, Prague in year 2005. The project „Human Capital in IS/ICT Operations and Development: Competitiveness of Czech Tertiary Education Graduates“ was processed at the Czech Science Foundation under the number 402/09/0385.

During the last five years we have realised five surveys. Three of them were realised among universities and HEIs in the years 2006, 2009 and 2011. They were focused on probing the knowledge of ICT study programs graduates. Another two surveys were realised in the years 2006 and 2010 among companies. The aim of these surveys was to find out requirements especially on knowledge quality of future employees in ICT managerial positions. Results of these surveys were published in (Doucek et al., 2007; Doucek, 2010; Maryska, 2010).

We started by comparing the overall development of number of students in the countries of EU27. Countries of EU27 have almost 500 million inhabitants. There are studying more than 18,5 million students at the universities and HEIs in these countries. The number of students in tertiary education has been increasing in the Czech Republic and other countries since year 2000, but there are also other countries in the EU27 where the number of students in tertiary education system is decreasing. This fact is presented in the Figure 2. The number of students is still increasing in the Czech Republic and it was increasing from 2,53 % to 3,98 % between years 2001 and 2009. It means that the growth was more than 1,45 percentage point (difference between 3,98 % and 2,53 %). In the Slovenia the number of students increased only by 1 percentage point - from 4,6 % to 5,6 %.

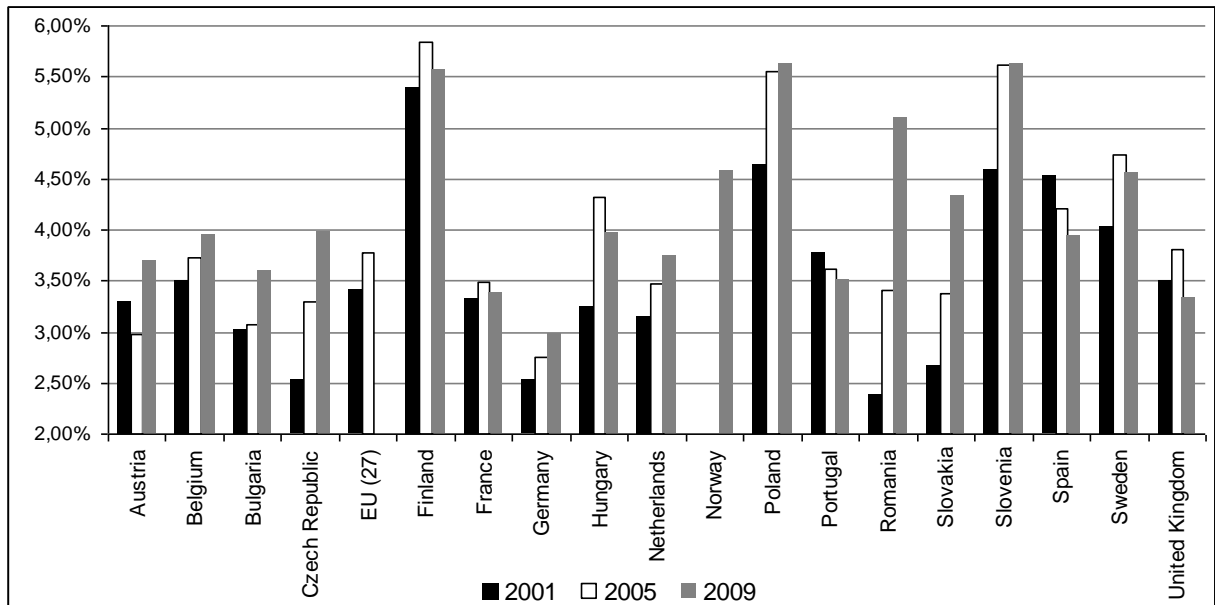


Figure 2: Ratio of Students at all Universities in Selected EU Countries (Eurostat, 2010; Eurostat, 2010a)

Although both of compared countries have their tertiary system based on the Bologna system, we can't make pinpoint comparison.

Accreditation commission of the Czech Government is approved disproportionate number of HEIs in comparison to the Slovenia. The second problem is related to the number of study programs at all study levels. Very important is especially number of study programs at bachelor and doctorate level. These findings are followed by Ministry of Education, youth and sports that is planning to reduce the number of study programs. This reduction provides easier orientation and selection from offered study programs to applicants.

The classification of study programs in Slovenia is absolutely different from the classification in the Czech Republic. Professional study programs in Slovenia are especially known. In the Czech Republic this type of study hasn't been established yet.

Approximately 10.510.000 inhabitants live in the Czech Republic (CSU, 2010). We compared this number with the number of studying students at the universities and HEIs. We found out that less than 4,0% of the Czech population is in active study process. At the public universities there are studying approximately 86,78% students and at the HEIs studying 13,20% students from total number of students. In the Czech Republic lives 3.105.000 inhabitants younger than 26 years (CSU, 2010) which represent 29,54 % of the whole population.

An approximately 2.050.000 inhabitant is living in the Slovenia and 5,56 % of population visit universities in the role of students. At the universities 114.873 students were studying in the year 2009. In the Slovenia there is 579.242 inhabitants that are younger than 26 years (SOFS, 2010) which represents 28,26 % of population. (Of all inhabitants younger than 26 years in the Slovenia the percentage studying at all universities makes 19,81%.)

The evolution of the twenty-year population (see Figure 3) was significantly decreasing between years 2001 and 2004 in EU27 and in the Czech Republic too. The period between 2004 and 2008 was relatively stable, and between 2008 and 2010 a growth and a subsequent decline is significant in the Czech Republic and it is possible to predict that it will be similar

in EU27 (as data for 2010 are not available yet). The evolution of the twenty-year population is also slowly declining in a monitored period in Slovenia.

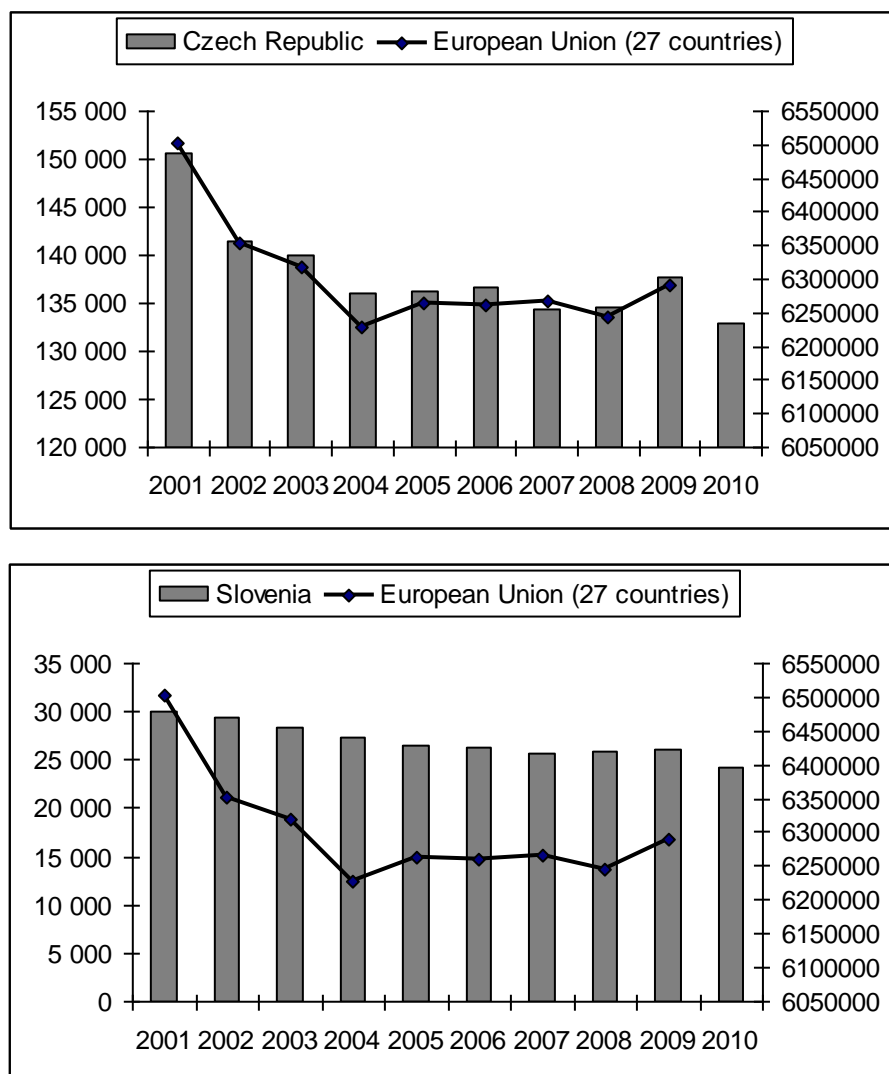


Figure 3: Trends in Number of Twenty-Years Old (Eurostat, 2010)

Situation presented in Figure 3 is important for the future development in the tertiary education system. The twenty-year population consists of students who began their studies at third level of the education system and those who entered the practice. Because we are solving the question how the education system responds to the requirements of the market, we have to compare the evolution of the twenty-year population with number of students visiting universities and HEIs. The trend is shown in the total number of students studying at the universities and HEIs in the Figure 4. The situation in Slovenia is relatively stable, but in the Czech Republic is visible an increasing trend in total number of students in tertiary system could be seen. The graph is prepared for the total number of students based on date presented in Table 2 **Error! Reference source not found.** and in Table 3 **Error! Reference source not found.** without splitting them in the context of the number of study programs or study levels.

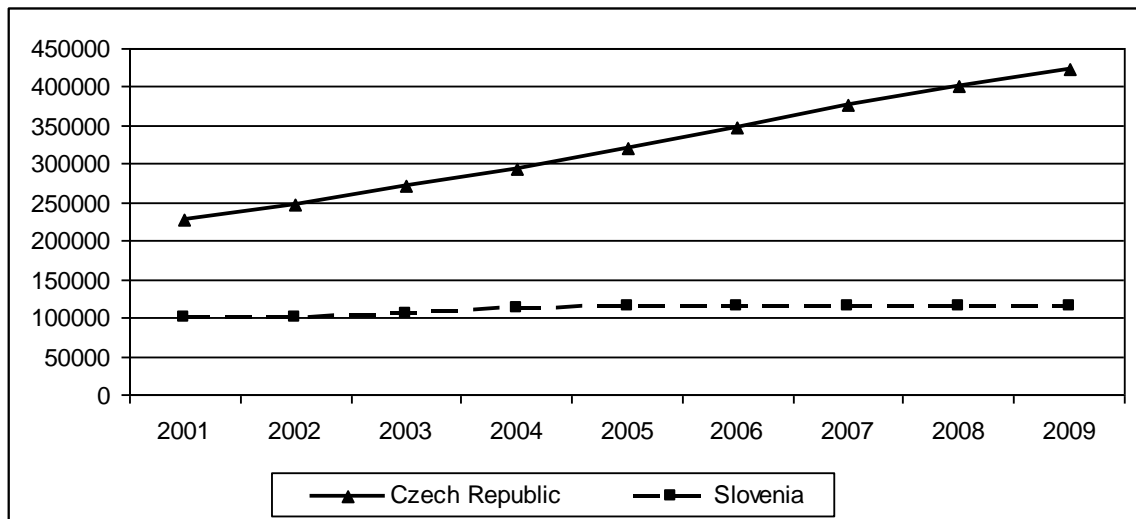


Figure 4: Trends in Numbers of Tertiary Education Level Students (UIV, 2010)

This comparison gives us at least following information:

- Number of students is increasing, especially in the Czech Republic.
- Number of students is much greater in the Czech Republic.

Detailed information about numbers of students is shown in Table 2 and in Table 3.

The Table 2 is **Error! Reference source not found.** prepared for Slovenia and it contains detailed information about number of students in different types of study and different study level. Acceptation of the Bologna declaration resulted in increasing numbers of students in Bologna-aligned study programs and decreasing numbers in other study programs. Total number of students in the Slovenia in master level is increasing in last nine years and the same conclusion is also for doctorate and higher vocational level. Other levels are decreasing, but in the context of the Figure 4 the total number of students is stable.

Slovenia	2001	2002	2003	2004	2005	2006	2007	2008	2009
Total students - bachelor	94 270	95 852	98 304	103 850	106 450	107 257	105 761	102 860	98 973
Total students - master	4 944	5 606	6 092	7 414	7 287	7 437	8 102	9 537	12 491
Total students - doctorate	0	0	0	964	1 057	1 250	1 582	1 994	3 409

Table 2: Trends in Numbers of Students in Tertiary Education System in the Slovenia (SOFS, 2010)

Situation is different in the Czech Republic (see Table 3 **Error! Reference source not found.**).

Czech Republic	2001	2002	2003	2004	2005	2006	2007	2008	2009
Total students - bachelor	44583	63490	94606	129 857	162 730	192 993	222 362	246 110	262 552
Total students - master	167326	165226	157599	142 267	134 348	130 885	129 796	131 210	135 179
Total students - doctorate	16671	18292	20288	21 666	22 536	23 494	24 144	24 716	25 859

Table 3: Trends in Numbers of Students in Tertiary Education System in the Czech Republic (UIV, 2010)

Differences between both analysed countries in indicator „number of graduates“ are shown in the Figure 5. We see that the trend in increasing number of graduates is lower in Slovenia.

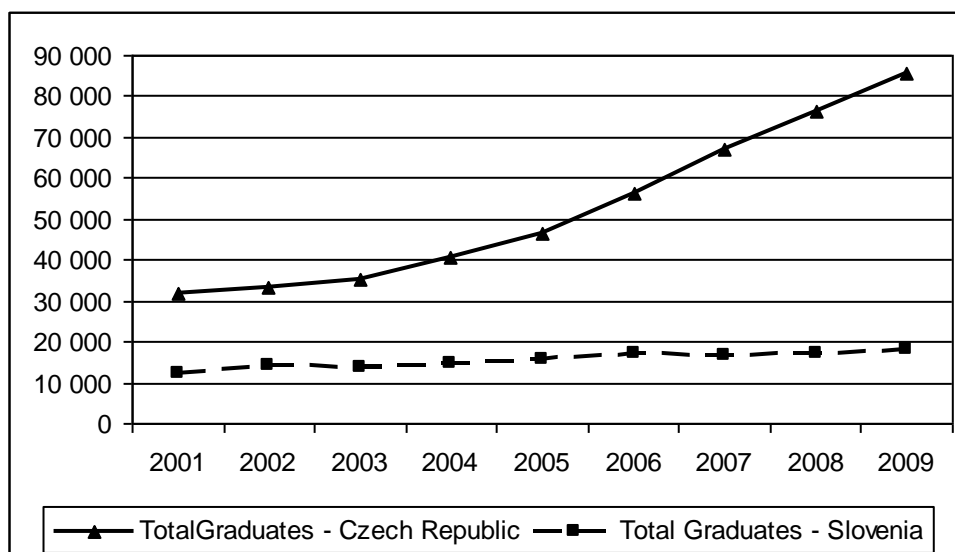


Figure 5: Number of Graduates in Czech Republic and Slovenia (SOFS, 2010)

Numbers of graduates are shown in Table 4. They are segmented according to the level of study in the Czech Republic and Slovenia. Numbers in this table confirm actual trends in the tertiary education. The number of students and also graduates is permanently increasing. There are only two exceptions. The first one is in higher vocational study in Slovenia and the second one is in doctorate study in the Czech Republic. In these two cases the number of graduates was decreasing.

Table 4: Numbers of Graduates Segmented According to the Level of Study (SOFS, 2010)

	2001	2002	2003	2004	2005	2006	2007	2008	2009
Slovenia - Bachelor	10 788	12 902	12 482	13 437	14 272	15 226	14 769	15 171	15 717
Slovenia - Master	905	1 058	1 082	1 096	1 146	1 524	1 496	1 645	1 920
Slovenia - Doctorate	298	318	367	355	369	395	415	405	466
Total Graduates - Slovenia	11 991	14 278	13 931	14 888	15 787	17 145	16 680	17 221	18 103
Czech Republic - Bachelor	7 835	8 031	8 588	12 042	18 356	25 342	33 607	39 856	46 359
Czech Republic - Master	23 001	23 724	24 953	26 926	26 298	28 638	31 013	34 241	36 713
Czech Republic - Doctorate	1 090	1 355	1 542	1 772	1 972	2 093	2 288	2 370	2 346
Total Graduates - Czech Republic	31 926	33 110	35 083	40 740	46 626	56 073	66 908	76 467	85 418

Partial Conclusion – RQ1: Does the number of undergraduate and graduate students correspond with the development of the population?

Permanently increasing number of students in the majority of European countries can be identified. The value of the same indicator for EU 27 has also increasing character. From Figure 3 situation in different countries can be seen. There are only few countries where the number of students is declining (France, Finland, Hungary, Portugal, Spain, Sweden, United Kingdom), but the deterioration is very low (Figure 3) and could be caused by twenty-year population decline. We conclude from presented facts, that although number of twenty-year population is declining, number of students is increasing and innovation potential of EU 27 economic is increasing.

5 Quantitative Characteristics in ICT Related Study Programs

ICT specialist is a general term that includes many professions. (Doucek, 2009) Generally, the fact that these specialists are prepared at the ICT-related study programs for business practice can be certified. Study programs with the topic of ICT are offered at almost all of the universities. Some of them are offered only at bachelor level and others are offered at master and doctorate study level also.

Faculties at public universities and also HEIs that offer ICT-related study programs were identified. The number of students, graduates and other interesting characteristics for both countries was performed and analysed. The most important information sources for this analysis were (MSMT, 2010; UIV, 2010; CSU, 2010; MES, 2010; SOFS, 2010). These information sources are not explicitly cited in the following text.

5.1 Number of Students in ICT Related Study Programs

If we solve the problem of lack of ICT specialists we must focus on the numbers of students.

Numbers of students in ICT-related study programs are presented in Table 5 and in Table 6. If we compare the numbers in the year 2009 we can see that there are nine times more students of all levels in the Czech Republic than in Slovenia. As we noted above, we need to recalculate these values according to the population. The ratio is 3 ICT students per one thousand inhabitants in the Czech Republic and 1,7 ICT student per one thousand inhabitants in Slovenia.

Table 5: Number of Students in ICT-related Study Programs in the Czech Republic, (MSMT, 2010; UIV, 2010)

Czech Republic	2004	2005	2006	2007	2008	2009
Total students - bachelor	14 124	16 994	20 336	22 488	23 334	22 818
Total students - master	6 952	6 880	7 147	7 473	7 723	8 018
Total students - doctorate	1 137	1 190	1 164	1 272	1 425	1 583

Table 6: Number of Students in ICT-related Study Programs in Slovenia (SOFS, 2010)

Slovenia	2004	2005	2006	2007	2008	2009
Total students - bachelor	2 903	3 060	3 230	3 442	3 326	3 395
Total students - master	132	111	139	150	154	99
Total students - doctorate	56	51	69	78	85	138

Figure 6 shows a large difference between the Czech Republic and Slovenia in the numbers of students in ICT-related study programs at the master level with regard to the bachelor level.

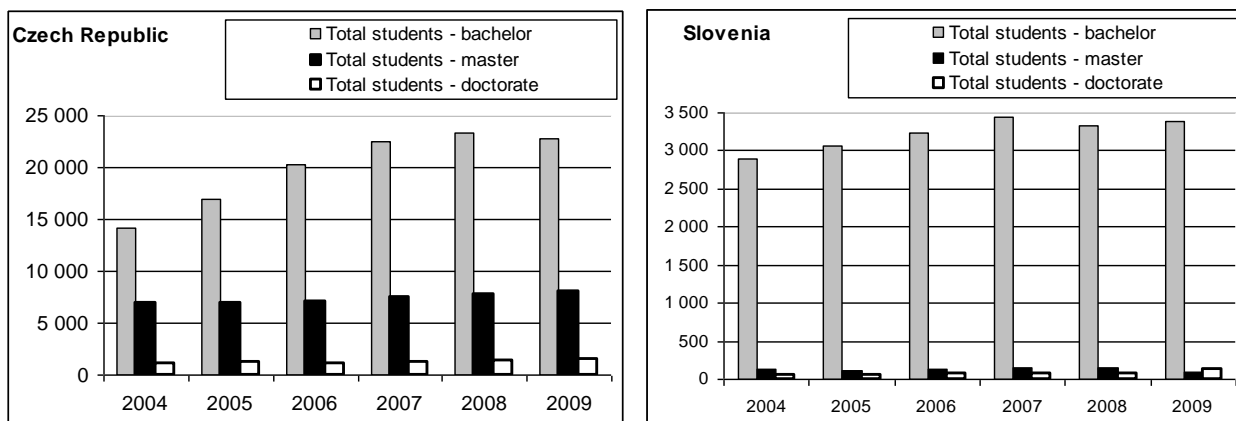


Figure 6: Trends in Number of Students in ICT Related Study Programs (MSMT, 2010; UIV, 2010; SOFS, 2010)

The trends in number of ICT students and the trends in total population had to be compared. (see Figure 7). While the population of both countries is slightly increasing, the number of ICT students increases significantly by 2007. The different trend is visible in the years 2007 – 2009.

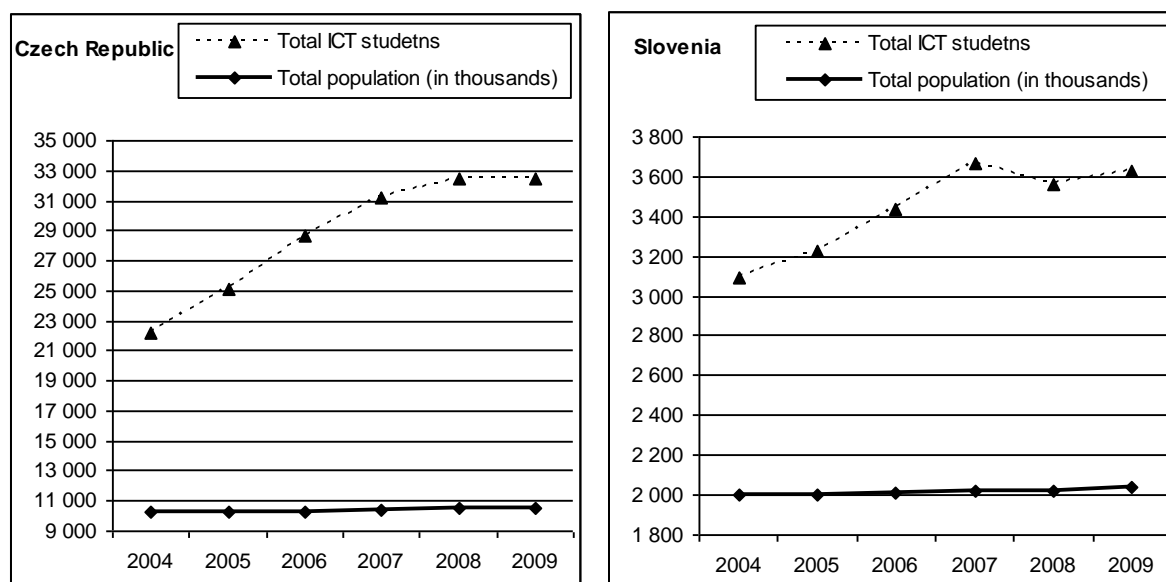


Figure 7: Comparison of Number of Students in ICT-related Study Programs with Total Population in the Czech Republic and in the Slovenia (MSMT, 2010; UIV, 2010; SOFS, 2010)

Similar comparisons are shown in Figure 8 and Figure 9. The difference is in total population that is replaced by number of students in all study programs. Trends identified from data sources confirm that the situation in Slovenia is still stable. There are only minimal changes in the numbers and ratio mentioned. The ratio of numbers of students and numbers of ICT-related students is smaller in the year 2009 than in previous years in the Czech Republic. This was caused by dynamically increasing number of students in all study programs and decreasing number of students in ICT-related study programs. Although the decrease is not too big, it is not good news for universities providing ICT-related study programs and also for the economy that still needs others ICT specialists (see Doucek et al., 2007; Maryska, 2010).

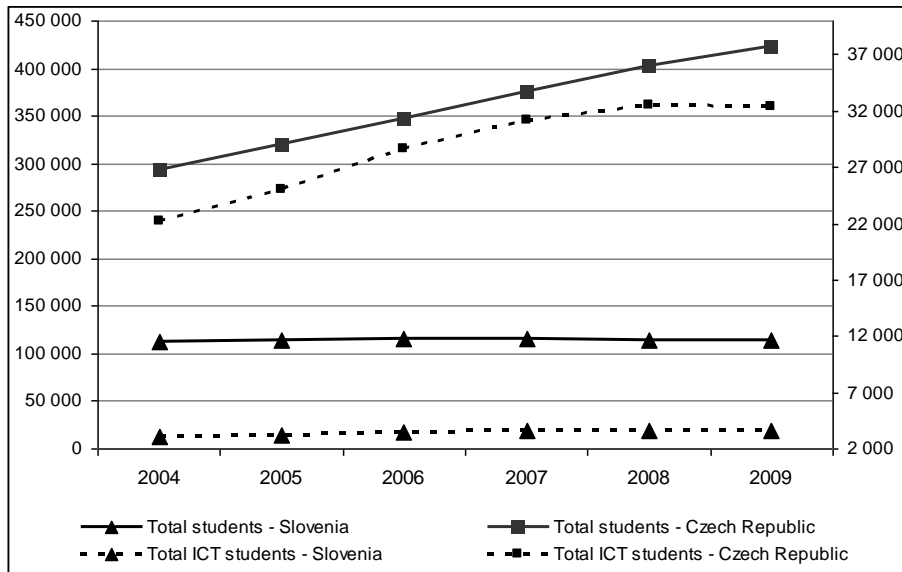


Figure 8: Trends in Total Number of Students and Number of Students in ICT Related Study Programs (MSMT, 2010; UIV, 2010; SOFS, 2010)

Comparison in absolute values provides information about trend in each of analysed countries but doesn't allow to make comparison between different countries. From this reason is important to make comparison in the form of ratio where in the numerator is placed number of ICT-related students and in denominator is number of population in the analysed country. The ratio of ICT students in the population rises significantly more in the Czech Republic than in Slovenia as it is shown in Figure 9.

As we see in the Figure 9, the ratio is more convenient in the Czech Republic. It should be noted that comparing only the quantitative characteristics corresponds to quantitative oriented issues. On the basis of our other research (Novotny, 2010) it could be demonstrated that knowledge level in ICT area and the level of e-skills of total population is better in the Slovenia.

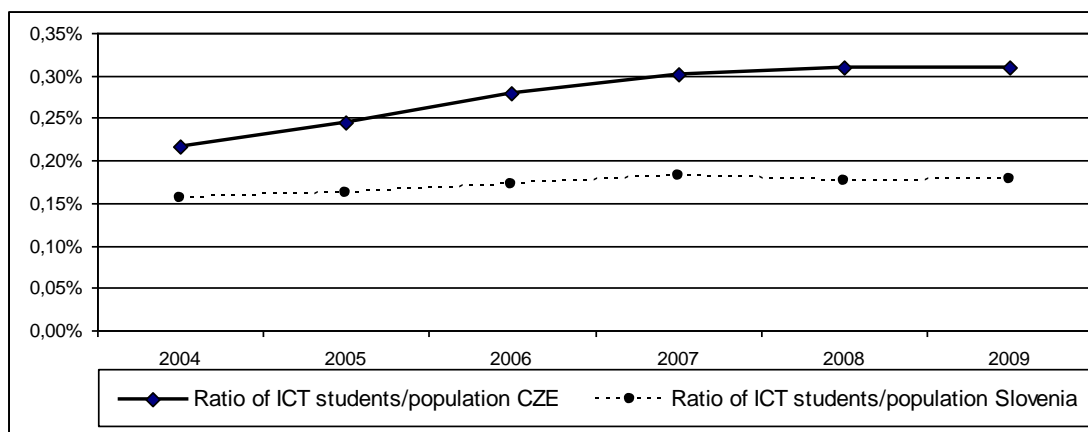


Figure 9: Ratio of Number of ICT Related Students to the Population (MSMT, 2010; UIV, 2010; SOFS, 2010)

Interesting comparisons are shown in Figure 10 – Figure 12. There the trends of the numbers of unsuccessful students with number of students in general are compared. This is performed for each level of study. As we see, the trends have different directions.

Total number of student and number of unsuccessful students develops similar at the bachelor level of study (see Figure 10).

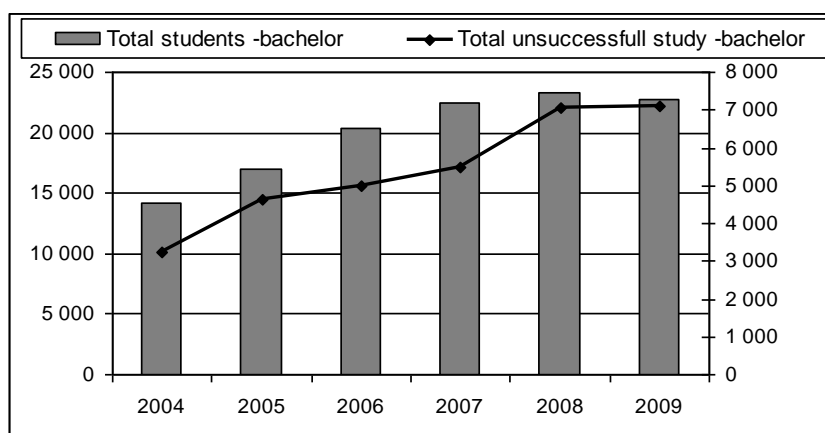


Figure 10: Comparison of Unsuccessful Students and Total Number of Students in ICT Related Study Programs at the Bachelor Level in the Czech Republic (MSMT, 2010; UIV, 2010; SOFS, 2010)

At the master level of study the total number of students is also increasing but the number of unsuccessful students is decreasing.

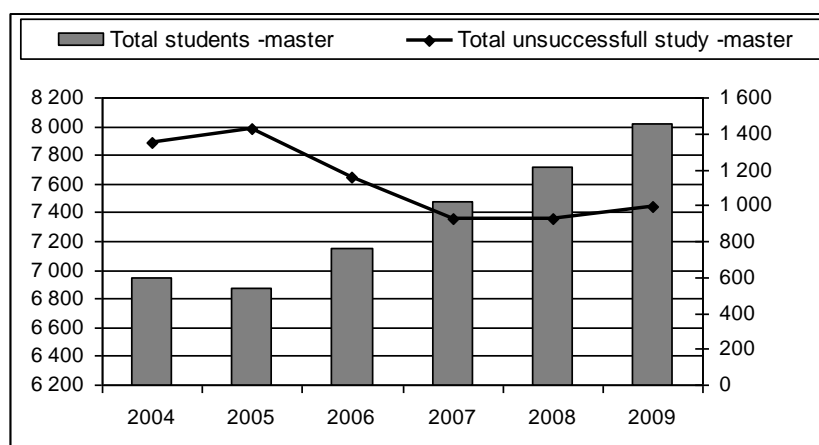


Figure 11: Comparison of Unsuccessful Students and Total Number of Students in ICT Related Study Programs at the Master Level in the Czech Republic (MSMT, 2010; UIV, 2010; SOFS, 2010)

Very heterogeneous trends are at the doctorate level of study.

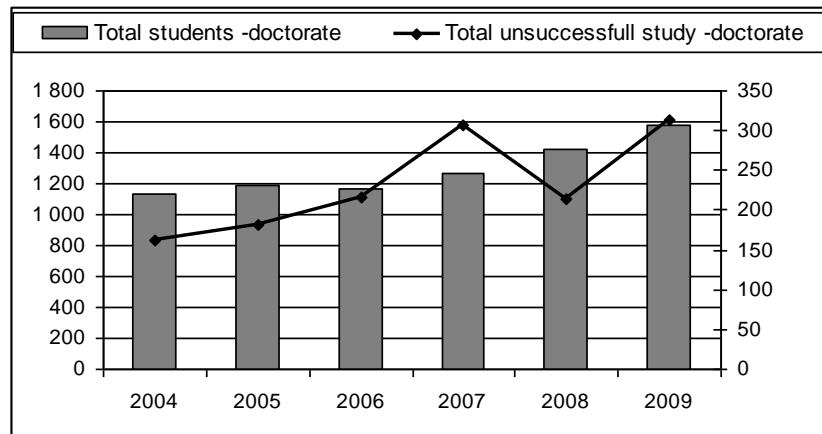


Figure 12: Comparison of Unsuccessful Students and Total Number of Students in ICT Related Study Programs at the Doctorate Level in the Czech Republic (MSMT, 2010; UIV, 2010; SOFS, 2010)

We usually say in the Czech Republic that the HEIs are easier to pass than public universities. The reason for this statement is usually the fact that the HEIs are private and students pay the owners for their study. In the case we try to calculate the ratio of unsuccessful study at universities and the HEIs using following formula, really interesting numbers could be found.

The ratio of unsuccessful to successful students at HEIs in the Czech Republic is 18,66 %. At universities, the same indicator has the value of 26,69 %. The difference in ratios of unsuccessful students in the Czech Republic is 8,03 % point.

In the Figure 14 the trends in ratios of unsuccessful students at HEIs and universities in the Czech Republic are presented. This graph presents these trends at HEIs and universities in general and also at HEIs and universities offering ICT-related study programs in the period of 2004 - 2009. It could be seen that the ratio at universities is higher than the ratio at HEIs. The ratio of unsuccessful students is approximately about 4–7% higher at universities than at HEIs.

We found out that the ratios of unsuccessful students at universities and HEIs offering ICT-related study program is higher than ratios of universities and HEIs in general. Really interesting is the fact that the rate of unsuccessful students at the HEI offering ICT-related study programs is higher than the ratios of unsuccessful students studying at universities in general. This comparison can't be prepared for the Slovenia tertiary education system because we were not able to separate numbers of students studying at universities and HEIs exactly.

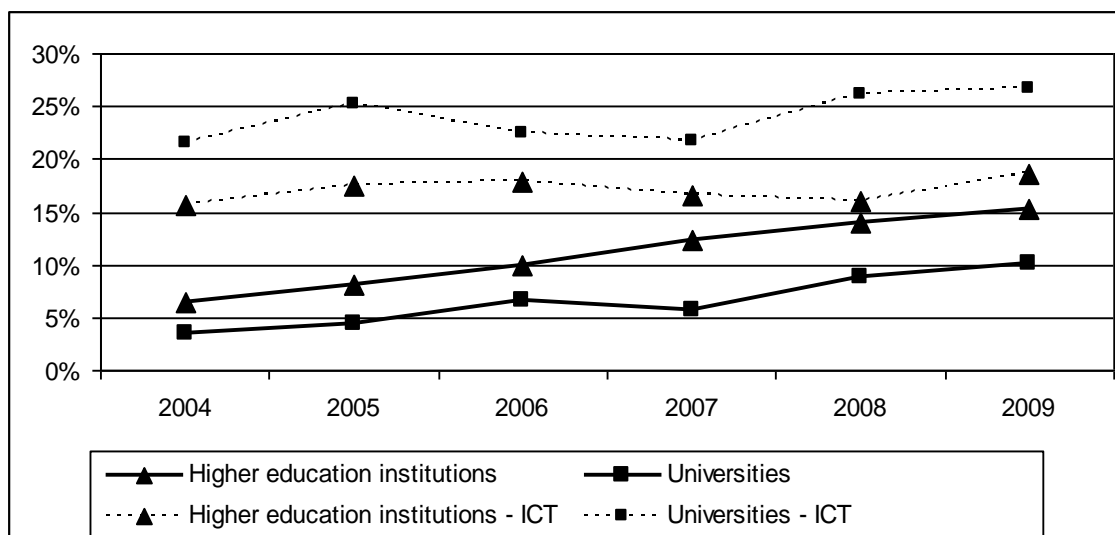


Figure 13: Trends in Unsuccessful Students at Universities and HEIs Offering ICT Related Study Programs (UIV, 2010)

The trends in the numbers of graduates in ICT-related study programs in the Czech Republic that are entering the labour market are described (see Figure 14). Really dynamical increase in numbers of graduates in ICT-related bachelor study in year 2004 could be seen. For example, approximately 400 graduates of ICT-related bachelor study programs entered the labour market after finishing bachelor study in year 2001. Contrary to this fact, more than 1.000 graduates of ICT-related master study programs entered to the labour market in the same year. At bachelor level of ICT-related study programs were dynamical increased in the numbers of students (see Figure 14) since year 2002 and with delay in 2-3 year this increase was followed by dynamical increase in number of graduates in ICT-related study programs.

These findings confirm expectations of universities and HEIs concerning the numbers of graduates in ICT-related study programs from year 2006 were mentioned for example in (Doucek et al., 2007). It could be seen that the trends in numbers are different since the year 2006. Numbers of graduates in ICT-related study programs are stable and oscillate between 2.000 and 2.200 graduates since year 2006.

At master level in ICT-related study program, the trends different are. Trends in numbers of graduates are presented by increase in numbers of graduates in ICT-related study programs. The highest increase in number of graduates was between years 2005-2008. This was caused by 2-3 year delay after increasing number of students at bachelor level.



Figure 14: Numbers of New ICT Specialists Entering Labour Market – the Czech Republic (UIV, 2010)

Partial Conclusions - RQ2: Does tertiary education system in ICT-related study programs react on increasing dependency on ICT?

Tertiary education system reports adequate reactions on ICT specialist requirements almost in all European countries, but demographical aspects in number of twenty-year population could in short future cause difficulties for Czech Republic and Slovenia. Requirements on greater number of ICT graduates in all levels of education based future scenarios presented on Figure 1 could be expected. Numbers of ICT students report stagnation since 2007 (Czech Republic and Slovenia); but this constant number of ICT-related study programs graduates cannot satisfy increasing demand on ICT specialist in order to continue building of information society in Europe.

6 Conclusions

Results presented confirm expectation of universities and HEIs concerning future numbers of graduates in ICT-related study programs. These expectations are mentioned for example in (Doucek et al., 2007; Doucek, 2010; Maryska, 2010). From the graphs presented high increase in numbers of graduates entering labour market results. This is really important in the context of gap between supply and demand of ICT specialists. In the case the companies have the same requirements on numbers of new employees as specified for example in (Doucek et al., 2007), the gap doesn't exist and the demand for ICT specialists is fully covered by the supply of new ICT specialists. Conclusions about quality of graduates in ICT-related study programs that are presented for example in (Maryska, 2010) could also be added. It could be said that current state from the view of the numbers of ICT specialists required by companies and provided by universities and HEIs is favourable. The verification of this conclusion will be realised through survey done between universities, HEIs and companies realised from December 2010.

From the analysis presented in this contribution on tertiary education of ICT specialists for ICT labour market in both countries, following trends are visible:

- Evaluation of starting position of Slovenia and the Czech Republic from the point of view in 2010:

- Demographic process in both countries signals decreasing number of teenager population in oncoming period. For the Czech Republic this progress could be expected for next ten years (Figure 4).
- Relative indexes of numbers of students and ICT students to thousand of population for the Czech Republic (qualitative aspects of tertiary education are not investigated in this contribution) are more convenient.
- Slovenia is more familiar with the Bologna study system (3 years bachelor level and 2 years of master level) in all study programs than the Czech Republic (Figure 13). Master study and doctoral study programmes in Slovenia are focused on elite group of students. For the Czech Republic another model is typical, where one third of bachelor programmes graduates continue their studies on master level. Doctoral level has top level character in both countries (Figure 13).
- Decreasing number of students and graduates especially on bachelor level in oncoming period in both countries as a result of demographic trend (Figure 4) could be expected. This trend could influence negatively (could have negative impact on) further evolution of information society not only in both countries but also in the whole Europe. Scenarios for e-skills demand (Figure 1) in Europe for period since 2007 to 2015 evoke massive need of ICT specialist; especially in cases of intensive boom of economic growth based on ICT use.
- **Forecast** – trends in numbers (share from the whole population) of ICT professionals incoming into the economy in future five years will be permanently more suitable for the Czech Republic (Figure 5).

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