Abstract

Knowledge Based Economy in the European Regions. Transformations in the world economy, particularly their acceleration observed at least since the 1980s in highly developed countries, are responsible for the fact that economic literature contains such terms as: new economy, knowledge-based economy, digital economy, or network economy. These concepts, regardless of their ambiguity and imprecision, were sometimes used interchangeably and most frequently related to the higher extent of using information technologies. The concept of knowledge-based economy originated from the need to differentiate some specific features of the contemporary economy which uses accumulated knowledge capital on a larger and larger scale. There is no universal tool to measure how advanced knowledge-based economy is. We may assume that such economy is characterised by a more rapid growth of expenditures on R&D and education than on investment in fixed assets. For the development of knowledge-based economy, not only the creation of new knowledge but also the ability to absorb knowledge and use it effectively in the processes of production are of crucial significance.

The research scheme has been based on the following questions:

What is the role of knowledge in the process of economic growth, what is the impact of knowledge on the processes of production, innovativeness and competitive advantage in regions? What is the essence of knowledge spillovers? Do they occur between units of the same branch or also between branches and between regions? (Chapter 1).

Today, no one questions the importance of knowledge for corporate growth (*e.g.* Julien 2007), regional development (*e.g.* Chojnicki, Czyż 2006; Cooke *et al.* 2007; Domański 2000; Simmie 2003) and economic growth on a macro-scale (*e.g.* Gomułka 1998; Welfe 2007). Attempts to explain cognitive processes have led to a new sub-discipline – knowledge economics – which treats knowledge as an effect, public or private good being an element of welfare (*e.g.* Foray 2006). Knowledge as a factor of production, apart from land, capital and labour, was introduced into neoclassical models of economic growth already in mid-1950s (*e.g. Domański 2005a* Verspagen 2007). Knowledge and innovations are also regarded as the main factors of building competitive advantage (*e.g.* Porter 1990). However, explanation of *knowledge spillovers* mechanisms at different levels – branches, clusters, regions – is difficult (*e.g.* Cowan 2005; Stel van Nieuwenhuijsen 2004) and requires further research.

Does geographical proximity between units facilitate the processes of learning and innovativeness? Are other forms of proximity identified in economics complementary or rather substitutional as regards geographical proximity? When and why do they facilitate mutual learning and ability to innovate? (Chapter 2).

Advantages of location for enterprises operating in close proximity result from using common infrastructure and common labour market. However, widely understood external advantages of agglomeration identified by Marshall result not only from close proximity but also

from co-operation and competition of enterprises. Apart from geographical proximity, economics also identifies cognitive, social, relational, institutional and organisational proximity (*e.g.* Boschma 2005; Cooke 2006). To some extent they are complementary and their effects may supplement each other. Physical proximity seems to be significant for the process of learning and innovations because the transfer of tacit knowledge requires direct contacts. The development of IT may, to some degree, reduce the significance of direct contacts in transferring codified knowledge, decreasing the need for and frequency of direct contacts which often assume periodical or sporadic character. Still, however, territorial features, including social and cultural proximity, may prove to be important in building a region's competitive advantage.

Do systems of innovation facilitate the use of knowledge in the processes of economic growth, raising innovativeness and building regional competitive advantage – and if so – why? (Chapter 3).

Complexity of both the innovation process and the factors of effective application of knowledge to the processes of production requires that many conditions are to be fulfilled simultaneously. Therefore, it seems that effective co-operation of R&D units, universities, enterprises, intermediary units as well as administrative authorities co-ordinating scientific and economic policy is one of the necessary conditions of innovative development and regional competitive advantage in knowledge-based economy. Systems of innovation may be one of the ways to ensure effectiveness of the process of innovation (*e.g.* Carayannis, Campbell 2006; Edquist 1997; Pangsy-Kania 2007), but their efficiency is very differentiated, depending frequently on a country's economic model and its sectoral policies.

How does spatial differentiation in the advancement of knowledge-based economy change in Europe? Is this differentiation and innovativeness in European regions increasing or decreasing under implementation of the Lisbon Strategy? (Chapter 4).

It is very difficult to define knowledge-based economy despite the fact that this concept is commonly used in economics (*e.g.* Domański 2005b; Galar 2001; Woroniecki 2001). The European countries and regions differ considerably as regards advancement of knowledge-based economy. Although the Lisbon Strategy is being implemented, those differences seem to be of permanent character. The analysis of common coefficients and non-hierarchical analysis of clusters identify regional dimensions of knowledge-based economy and distinguish five types of regions which differ in the volume of R&D expenditures, modernity of economic structure, features of human capital and GDP *per capita*. Out of the studied regions (NUTS 2) merely 32.6% may be qualified as those with advanced knowledge-based economy, whereas until 2004 the remaining regions had not possessed sufficient knowledge capital or had not used it properly.

Can the impact of knowledge capital on the level of economic productivity and patent activity in European macro-regions be quantitatively estimated? What supplementary factors decide about productivity of knowledge capital in those spatial units? (Chapter 5).

Regression analysis explains whether labour productivity and patent activity in European macro-regions (NUTS 1) in the years 1999-2004 depended on the volume of expenditures for R&D, human resources for science and technology, employment in R&D sector, as well as such variables as: density of R&D units, rate of urbanisation and employment in the manufacturing industry of high and medium-level technology and employment in high technology services. Those hypotheses were first verified in single-factor regression models and later on in multi-factor models in the group of 82 macro-regions the data for which were available from the Eurostat.

Curvilinear dependencies between the studied variables were identified. It is difficult to interpret them because of non-uniform administrative status of the analysed spatial units, however it is possible to make some conclusions on the force of impact of knowledge capital, in its different dimensions, on both labour productivity and, to a lesser degree, patent activity. As regards the latter it was necessary to include country – specific features in the model.

How can interdependencies between knowledge capital, R&D expenditures as well as human capital in the R&D sector and labour productivity in different regions be quantitatively identified? Are these dependencies in Europe regionally differentiated and – if so – what do they depend on? (Chapter 6).

It is assumed that knowledge resources are not a public good but they have many characteristics of a private or a club good and creation of knowledge potential and its use in the economy requires higher financial expenditures. The regions where the volume of R&D expenditures is high are also characterized by a high knowledge capital. Sectoral structure of expenditures as well as the structure of employment in executive sectors: government, enterprises and higher education, are very significant for the effective use of knowledge capital. If this capital is supplemented by specific features of human capital (high indicators of human resources for science and technology as well as high density of employment in the R&D sector) and technological advancement of industry and services, it will positively influence labour productivity of the regional economy. These hypotheses are verified in the set of European regions (NUTS 2) and in three purposefully differentiated sub-groups: South-West Europe, the regions of Germany and Austria and the regions of Central–Eastern Europe. Both single-factor and multi-factor nonlinear models of regression are used. The analysis makes it possible to quantitatively define the influence of particular features of knowledge capital on the regions' labour productivity.

How can advancement of knowledge-based economy in Poland's voivodships be assessed and how has it changed in recent years? Are there any difference between knowledge capital and innovativeness of the voivodships' economy, and if so, what do they result from? (Chapter 7).

Earlier publications as regards advancement of KBE (*e.g.* Cooke *et.al.* 2007; Strahl, Markowska 2007), show that Poland and its particular voivodships have a low position in the rankings made for Europe. Moreover, internal potential of knowledge is very much diversified in voivodships (*e.g.* Chojnicki, Czyż 2006). The analysis confirms the existing differences and simultaneously reveals differences between scientific potential and simple indicators of product and process innovativeness in the manufacturing industry in the years 2003-2006. This may be a threat to maintaining competitive advantage of the regions' economy. Those threats were persistent although most voivodships implemented innovation strategies and received financial assistance from the EU funds.

The level of knowledge-based economy in the European regions differs according to the following four dimensions (defined by the analysis of common factors): F1 – level of socio-economic development, F2 – knowledge capital, F3 – human capital, and F4 – high-tech level of economy. Those dimensions were correlated and in order to interpret them rotation of the value of factors proved to be necessary.

Non-hierarchical analysis of clusters based on the values of factors F1-F4 made it possible to distinguish five types of regions. **Type one** – regions with advanced knowledge-based economy, high expenditure for R&D reaching 2.7%-8.8% of the region's gross product and

very high patent activity, modern structure of their economy and a very high human capital. These were mainly German regions, *e.g.* Stuttgart, Karlsruhe and the Swedish region Vastsverige. **Type two** – regions of high knowledge capital and high level of economic development but of a lower human capital. They were also characterised by high patent activity. This type of regions included: Berlin, Hamburg, Cologne, Lazio, Vienna and – out of Scandinavian regions – Stockholm and Flevoland. **Type three** – regions of very high level of economic development but of a lower (than the previous two types) knowledge capital and of lower human capital. To this type belonged: Belgian regions, land of East Germany, part of Spanish regions (*e.g.* Catalonia, Madrid, and some French regions (*e.g.* Brittany, Rhone-Alpes), and out of East European regions – Prague and Bratislava land. **Type four** – regions of medium and low level of socio-economic development, weak human capital but relatively high knowledge capital. This type included as many as 79 regions, *e.g.* regions of Ireland, regions of Southern Italy, some Austrian and French regions (*e.g.* Picardy, Burgundy, Alsatia). **Type five** – regions of low level of socio-economic development, very low knowledge capital, traditional structure of economy and medium-level human capital. This group consisted of as many as 45 regions, including (apart from Prague and Bratislava) all regions of the countries which joined the EU in 2004. Until 2005 the regions of this type had still been at the stage of building knowledge-based economy.

Labour productivity and patent activity factors in the macro-regions (82 NUTS 1 units in the years 1999-2005) and in the European regions (182 NUTS 2 units in the years 2003 and 2004) were identified. An assumption was made that knowledge capital (reflected approximately by intensity of R&D expenditures in executive sectors) as well as human capital (based on *HRST core* index and intensity of employment in R&D sector) exert a significant influence on the socio-economic development of the regions (labour productivity). The impact of those factors was accompanied by additional factors, such as: employment in knowledge-intensive high-technology services, employment in high and medium-high tech manufacturing industry, the number of R&D units compared with the number of manufacturing industry enterprises and index of urbanization.

Results of the analyses for (NUTS 2) regions are most important. They showed that intensity of expenditures for R&D in the regions positively, but less than proportionally, influenced labour productivity and that the identified interdependencies were not of linear character. This growth was mostly influenced by the intensity of expenditures in the business sector, whereas most complicated were the forms of impact of R&D expenditures in the sector of higher education institutions. The share of people employed in knowledge-intensive high-technology services played the most significant role in the group of features describing the regions' human capital. Differences in the of impact of particular factors occurred between the regions of South-Western Europe, those of Germany and Austria as well as of those of Central and Eastern Europe (see Tables 6.9 and 6.10).

For the whole set of the studied regions, comprising both the regions which intensively apply knowledge in their economy (*e.g.* Scandinavian regions) and the regions of very low intensity of knowledge utilisation (*e.g.* peripheral regions of Portugal and some voivodships in Poland) the following generalisations were formulated:

1) A significant influence on the growth of labour productivity in the regions' economy was exerted by co-existence of a high share of people employed in knowledge-intensive high-technology services with a high volume of R&D expenditures per person employed in the

research development sector. The impact of those two main factors was strengthened by: patent activity *HRST core* indicators and saturation of the labour market with employees of R&D sector.

2) Co-existence of a high share of people employed in knowledge-intensive high-technology services with high volume of R&D expenditures in the sector of business and in the sector of institutions of higher education per one employee exerts a positive influence on the growth of labour productivity in the regions. The impact of intensity of R&D expenditures in the sector of business only slightly exceeds this impact in the sector of higher education and a high patent activity is a factor strengthening their positive influence.

Differences in parameters of the models estimated for the distinguished groups of regions made it possible to formulate the following conclusions:

1) Modern character of economy, described by the share of people employed in knowledge-intensive high-technology services, positively influences the growth of labour productivity in all the differentiated groups of regions, with this influence being the strongest in the regions of Germany and Austria and the weakest – in the regions of South-Western Europe.
2) Volume of expenditures for research and development per employee in the R&D sector exerted most positive influence on labour productivity in the regions of South-Western Europe. However, differences in this volume in the regions of Germany and Austria only slightly affected regional differentiation in labour productivity. This confirms the differences in *knowledge spillovers* between the regions in particular parts of Europe.
3) The share of people employed in R&D sector in the total number of a region's workforce strengthens, however only to a slight extent, a positive influence of GERD total intensity on labour productivity in the regions of Germany and Austria and those of Central and Eastern Europe, but weakens this influence in the regions of South-Western Europe.
4) High patent activity co-existed with high labour productivity in the regions of South-Western Europe, and even more clearly in the regions of Germany and Austria. However, no positive links between patent activity and labour productivity were identified in the regions of Central and Eastern Europe where in the studied period this activity was too low to exert any influence on economic growth.
5) In the regions of South-Western Europe the positive influence of co-existence of the high share of people employed in knowledge-intensive high-technology services with the high intensity of *GERD business* expenditures on labour productivity was strengthened by density of R&D units, high level of urbanization, high *HRST core* index and higher than average patent activity.
6) In the regions of Germany and Austria the share of people employed in knowledge-intensive high-technology services and high expenditures per R&D employee strengthened the high share of R&D employees and high patent activity, but no significant positive influence of *HRST core* indicators was revealed. This may mean that in those regions the cumulated knowledge capital and high expenditures for R&D are decisive for economic growth, however the human capital may prove to be insufficient in the future.
7) In the regions of Central and Eastern Europe slightly different factors decided about labour productivity than in the remaining two groups. A positive influence of the modern economic structure (share of people employed in knowledge-intensive high-technology services) was clearly strengthened by high *HRST core* indicators and (to a lesser degree

though) by the intensity of expenditures per employee in the R&D sector. However, if we assume that intensity of R&D expenditures in the whole economy is one of the factors of labour productivity in a region, it turns out that *HRST core* indicators and a high intensity of R&D expenditures in the sector of business are still of decisive importance, whereas the share of people employed in knowledge-intensive high-technology services plays a supplementary role. The coefficients estimated for the models suggest that in those regions human capital remains decisive for labour productivity.

Advancement of knowledge-based economy in Poland in 2006 against the background of highly developed European economies was low. The analysis showed that the economy of only eight voivodships, although they do not meet all the differentiated criteria, may be qualified as knowledge-based economy. In 2006 these were, in the order of importance: Mazowieckie, Pomorskie, Małopolskie, Śląskie, Podkarpackie, Dolonośląskie, Wielkopolskie, and Kujawsko-Pomorskie. The highest level of innovativeness, which is a significant feature of KBE, does not always appear in the voivodships with high knowledge capital. In the voivodships of high scientific-research potential (Wielkopolskie, Lubelskie and Łódzkie) there appear problems with using the knowledge capital in enterprises, whereas in the regions of medium-high scientific potential inter-regional knowledge *spillovers* are used (*e.g.* Podkarpackie and Kujawsko-Pomorskie).

In order to increase the possibilities of using knowledge capital in the process of economic growth, different instruments should be used in the core regions from those applied in the peripheral regions. The solutions – including regional systems of innovation – depend to a high degree on a country's path of development, the structure of a region's economy and on supra-regional environment.

Translated by:
Ewa Kotkowska, Bernadetta Klinikowska-Rosada