10.2478/v10103-009-0043-2

EDYTA DWORAK*

Analysis of knowledge-based economy impact on economic development in the European Union countries

Abstract

Directions of changes in the world economy occurring in recent years show the transition from industrial era economy to knowledge-based economy. Increasing investments in fixed assets is no longer a sufficient way of ensuring permanent economic growth. Research-development activity, innovation and human capital become decisive factors of development. As an essential determinant of the innovativeness level of individual economies are considered expenditures on research and development designed to conduct basic, applied research and development activities as well as effects of these research appearing in the form of innovations. The objective of the article is to analyze correlative connections between the two main variables describing knowledge-based economy, that is between the share of R&D expenditures in GDP and R&D expenditures per capita, and the remaining characteristics of knowledge – based economy. Another aim of the article is to assess the impact of these two variables on the basic macroeconomic indicators in the European Union countries, and, connected with them, to analyze the impact of knowledge–based economy on economic development of these countries.

* Ph. D., University of Łódź

1. Introduction

Directions of changes in the world economy occurring in recent years show the transition from industrial era economy to knowledge-based economy. Increasing investments in fixed assets is no longer a sufficient way of ensuring permanent economic growth. Research-development activity, innovation and human capital become decisive factors of development (Rodrigues 2003, p. 3-30; Neef, Siesfeld, Cefola eds. 1998, p. 34; Smith 2002, p. 23). The process of transition to knowledge-based economy is seen in the increase of competitive superiority of countries and regions specializing in manufacturing technologically advanced products. Innovativeness is then considered as one of essential factors deciding about the rate and quality of economic growth (Rooney, Hearn, Ninan 2005, p. 25-28; Stevens 1998, p. 45-54). Consequently the main subject of research conducted in highly developed countries is searching sources of innovativeness and constructing innovation potential which become a basis for creating knowledge–based economy (Miedziński 2001, p. 210; Foray, 2000, s. 57). As an essential determinant of the innovativeness level of individual economies are considered expenditures on research and development designed to conduct basic, applied research and development activities as well as effects of these research, appearing in the form of innovations (Stec 2009, p. 45-46).

The objective of the article is to analyze correlative connections between the two main variables describing knowledge-based economy, that is between the share of R&D expenditures in GDP and R&D expenditures per capita, and the remaining characteristics of knowledge–based economy. Another aim of the article is to assess the impact of these two variables on the basic macroeconomic indicators in the European Union countries, and, connected with them, to analyze the impact of knowledge–based economy on economic development of these countries.

2. Methodology of research

In the research of knowledge–based economy numerous variables describing its particular areas are used. And so eg. the basis of variables of Knowledge Assessment Methodology (Żelazny 2006) is statistical database provided by the World Bank in the framework of the "Knowledge for Development Program –K4D" which consists of more than 80 variables describing knowledge-based economy on macroeconomic scale. Here four principal pillars are distinguished: (A) Economic Incentive and Institutional

Regime, (B) Education and Training, (C) Innovation and Technological Adoption, (D) Information and Communication Infrastructure.

Another research of knowledge–based economy - the European Innovation Scoreboard (EIS) - is a special method created by the European Union the aim of which is to assess achievements, trends, strong and weak points of individual economies in the field of innovations. Till the year 2005 this method was based on the analysis of 17 indicators describing four areas of knowledge– based economy (European Innovation Scoreboard 2007, 2008). Since 2008 the European Innovation Scoreboard has been an analysis of 32 indicators of innovation activity grouped in three dimensions: (A) Innovation Carriers, (B) Activity of Enterprises and (C) Outputs (European Innovation Scoreboard 2008, 2009).

The following method of knowledge–based economy measurement, also elaborated by the European Commission, the Global Innovation Scoreboard, comprises the analysis of 9 indicators describing innovation activity and technological capacities of a researched economy. In this method indicators were grouped in the following pillars: (A) Firm Activities and Outputs, (B) Human Resources and Infrastructures and (C) Absorptive Capacity.

The research, the outputs of which are presented in this article, was conducted on the basis of a comprehensive Eurostat database describing knowledge–based economy grouped in three pillars: (A) Science and Technology, (B) Education and Training and (C) Information Society. The analysis of variables included in the mentioned pillars comprises the years 2000-2007. Accepting as the beginning of the analyzed period the year 2000 is connected with publishing the Lisbon Strategy which recognized as the main direction of development of the European Union making the Union economy by 2010 the most competitive economy in the world, based on knowledge which is characterized by a higher than now degree of social cohesion and gives more jobs. It can be stated that accepting by the EU countries the Lisbon Strategy began the process of building economies based on knowledge although the notion of this economy had appeared already in 1996 in the documents of OECD (The Knowledge-Based Economy 1996, p. 30-31). As far as the end of analysis in 2007 is concerned it should be stated that published by Eurostat statistics in majority do not cover later years, moreover at the moment of conducting the analysis some of time series were finished in 2006. Then for lacking variables their approximate values in 2007 were accepted on the basis of the trend function, which was possible thanks to sufficiently long time series (data since the year 1996 were considered). Regarding the incompleteness of data

concerning Cyprus, Malta and Luxemburg[1] the analysis was limited to 24 countries of the European Union.

The analysis of cause and effect correlations in the field of knowledge - based economy was conducted by means of Pearson` s linear correlation coefficient- the use of which was well- founded by the quantitative character of the examined variables and the lack of clear deviations from normality of variables distribution or linearity of relations among them. To compare Spearman`s analysis using the non-parametric coefficient of rank correlation was conducted, resistant to failure of the mentioned assumptions. The obtained results were very close to the results obtained through parametric methods. As the applied coefficient are widely known their detailed characteristic was left out.

3. Assessment of correlative connections between characteristics of knowledge-based economy in the European Union countries

For each country dependence of the main variables characterizing knowledge-based economy and the share of R&D expenditures in GDP and R&D expenditures per capita was examined[2]. Table 1 shows dependences between the share of R&D expenditures in GDP and the remaining variables describing knowledge-based economy in the researched countries of the European Union.

[1] The countries are so small that their outputs can be recognized as weakly representative for the whole European Union.

[2] The R&D expenditures are treated as an essentials measure of R&D activity and even as the main determinant of the innovativeness level of economies. See: Science and Technology in 2007, Central Statistical Office, Warsaw 2008, p. 31.

Table 1. The correlation between the share of R&D expenditures in GDP and the remaining variables describing knowledge-based economy in the European Union countries* in the years 2000-2007

The share of R&D expenditures In GDP	AT	B	BLG	CZ	DN	EST	FL	F	EL	ES	NL	IRL	LIT	LTV	D	PL	PT	RU	SLK	SLV	SE	HU	UK	IT
Human resources in science&technology as a percentage of labour force	++	--		++++	+	+++		--	-	++++		++++	+	+	+		++		---		---		+++	+++
Exports of high technology products as a percentage of total exports	--	+++				--	-	++		----	+++	---	++	+++	---				--	-		-	-	----
Employment in knowledge-intensive service sectors as a percentage of total employment	+	-	-	++++	+		+++	---		++++		+++		+	+++	-	+	+					++	
European high-technology patents per million inhabitants				++++	+	++		+			++	---			---							---	---	--
Gross domestic R&D expenditures (GERD) financed by industry as a percentage of GERD	+++	+++		++		+++	--					----			+			---	++++	++				+

Employment in high-and medium-high technology manufacturing sectors as a percentage of total employment				++++			---	+		----	++	----	---						----		+		-	
Government R&D expenditures as a percentage of GDP	++		++	++++		++++	+	++		++++	++	++++	++	++		+	++	++++	++++				++	
Patent applications to the European Patent Office per million inhabitants	++++	--		+				---		++++	++	++		++++		---	+++	+++	---					++++
Number of mobile phone subscriptions (1000)	++++			++	++	++++	+++	-		++++	--	++++	++++	+++	++		+++	++++	----		-	+	+++	++++
Mathematics, science &technology graduates per 1000 of population aged 20 -29	--			----		+++			-		++	----	----	---	++	---		---	++ ++		+++	--		
School expectancy	++++			++		++	+++			++	--	++++	++++			-		+++	----				--	+++
Median age in years	+	--		++		+++	++			++++		++++	+++	+	--			++	----					
Public expenditures on education as a percentage of GDP	---					----					-		---				--		+					
Four-years-olds in education (participation rate - %)	++++				+++	++++	++++			-		----	++++	+++	+++			+	----		---			---
Students per 1000 inhabitants		---		+++		++++	++++	--		----	---		++++	+	++	---	---	+++	----		--			+++

Foreign languages learnt per pupil		-			+								++	++				+++					-	+++
Annual expenditures on public &private educational institutions per pupil/student	---			++		----		++				++++	---				--		+				+	++++
Participation in education	----			---		----	-	++		++			---	--	--	+	-		++++		++	-	+++	
18-years-olds in education	++	--				+++	++++			++		+++	++++	+		-		+++	----				-	+
Science &technology graduates per 1000 of population aged 20-29	++++			++++	+	+					--		++++		+		++		----		---		-	
Internet access per 100 inhabitants	---			----			---	--		-	+++		--		++	-	-		+++	-	+++		++	
High-technology trade per capita in 1000 euro	++								-	++		---		++					--					

* Malta, Cyprus, Luxemburg were left out in the analysis.

++++ positive correlation, statistically significant ($p<0,05$); the correlation coefficient >0,9;

+++ positive correlation, statistically significant ($p<0,05$); the correlation coefficient (0,8;0,9);

++ positive correlation, statistically significant ($p<0,05$); the correlation coefficient (0,7;0,8);

+ positive correlation, essential with $0,05<p<0,10$; the correlation coefficient (0,5;0,7);

---- negative correlation, statistically essential ($p<0,05$); the correlation coefficient <-0,9;

--- negative correlation, statistically essential ($p<0,05$); the correlation coefficient (-0,9;-0,8);

-- negative correlation, statistically essential ($p<0,05$); the correlation coefficient (-0,8;-0,7)

- negative correlation, essential with $0,05<p<0,10$; the correlation coefficient (-0,7;-0,5)

Source: own calculations based on Eurostat data.

On the basis of values of the correlation coefficient between the share of R&D expenditures in GDP and the remaining variables describing knowledge-based economy in the researched countries of the European Union two groups of countries can be distinguished:

1. the countries in which appears a strong correlation (the correlation coefficient >0,9) between the share of R&D expenditures in GDP and the remaining variables describing knowledge- based economy; to this group belong: the Czech Republic, Estonia, Ireland, Lithuania, Romania, Austria and Italy;
2. the countries in which a strong connection between the share of R&D expenditures in GDP and the remaining variables characterizing knowledge-based economy does not occur; these countries are: Bulgaria, Belgium, Slovenia, Greece, Poland, Hungary.

It is worth mentioning that in case of Poland occurs a moderate positive correlation (significant with $0,05<\alpha<0,10$) between the share of R&D expenditures in GDP and the share of R&D expenditures in GDP, financed from the state budget (Government R&D expenditures as a percentage of GDP) (r=0,640), and the participation in education, measured by the share of students in public institutions in the total amount of students (r=0,628). However, the influence of R&D expenditures of industry is insignificant which is confirmed by the slight inclination of Polish enterprises to take up innovation activity. It is worrying that the majority of remaining characteristics of knowledge-based economy do not correlate positively which may indicate the fact that taken up activities do not make coordinated innovative policy of the state. Statistically essential is negative ($p<0,05$) and there is a strong connection of the share of R&D expenditures in GDP relating to such variables as: the number of patent applications in European Patent Office per million of inhabitants (r= - 0,872), the number of students per 1000 of inhabitants (r= -0, 835), and also the number of graduates in mathematics as well as science and technology fields (r= -0,871).

Table 2 presents correlation between R&D expenditures per capita and the remaining variables characterizing knowledge–based economy in the 24 European Union countries.

Table 2. The correlation between R&D expenditures per capita and the remaining variables describing knowledge-based economy in the European Union countries* in the years 2000-2007

R&D expenditures per capita	AT	B	BLG	CZ	DN	EST	FL	F	EL	ES	NL	IRL	LIT	LTV	D	PL	PT	RU	SLK	SLV	SE	HU	UK	IT
Human resources in science&technology as a percentage of labour force	++	+++		++++	++++	+++		----	+++	++++	++	++++	+++	+++	+++	++	+++		++++	+++	++	++	+++	++++
Exports of high technology products as a percentage of total exports	---	-	++++	+	--	-	---	----	--	----	-	----	+++	++++	----	+			+				-	----
Employment In knowledge-intensive service sectors as a percentage of total employment				++++			+++	+++	+++	++++	+++	++++		+	++++	++	++	++		++++		++	++	+++
European high-technology patents per million				++++		++	---	--			--	---			----						---		---	
Gross domestic R&D expenditures (GERD) financed by industry as a percentage of	+++		+++	++		+++	--					----			+++	++++	+	----	---	++				+++
Employment in high- and medium-high technology manufacturing sectors as a percentage of total employment				++++	-			---	+	----	----	----	---		-	+++			+++		--		-	

Government R&D expenditures as a percentage of GDP	++		---	++++		++++		--		++++	--	++++		++++	--		+++	++++	----			+++	++	
Patent applications to the European Patent Office per million inhabitants	++++		+++	++	++++			+++	+++	++++	-	++		++++	++++		++++	++++	+++	+++	++			++++
Number of mobile phone subscriptions (1000)	++++	++++	++++	+++	++++	++++	++++	++++	+++	++++	++++	++++	++++	+++	+++	++	+++	++++	++	+++		++++	+++	++++
Number of mobile phone subscriptions per 100 inhabitants	++++	++++	++++	+++	++++	++++	++++	++++	+++	++++	++++	++++	++++	++++	++++	++	+++	++++	++	++		++++	+++	++++
Maths, science &technology graduates per 1000 of population aged 20 -	--	++	++	----	---	++++			+		----	----	----	---	+++			---	----		+++	---		
School expectancy	++++		++++	+++	+++	+	++++		+++	+++	++++	++++	+++		+++	++		+++	++++	+++		++++	--	+++
Median age in years	+		+	+++	+++	+++	++++		+	++++		++++	+++	+	---			+++	++++	++++		+++		
Public expenditures on education as a percentage of GDP	---				--	---			++++		+++		----		-		--		---	---	---			
Four-years-olds In education (participation rate -	++++				++++	++++	++++			-		----	++++	++++	+++	+++		++	++++	++++		++	-	-
Students per 1000 inhabitants		+		++++	+++	+++	++++	+	+++	----	++++		++++	+	++		---	++++	++++	+++		++++		+++
Foreign languages learnt per pupil		-	++		+++								+++	++	++	---		+++	++	++++		+++	-	++++
Annual expenditures on public &private educational institutions per	---			+++	--	----		----	++++		+	++++	----		--		--		---	---	---		+	

Participation in education	----		----	---	--	---	----	----		++			----	--	----	--	--		---		++	----	+++	
18-years-olds in education	++	+	+++			++	+++	----		+++	+++	++++	+++	++		+		+++	+++	+++		+++	-	++++
Science &technology graduates per 1000 of population aged 20-	++++			++++		+	+++		++++		++++		++++		++++	+++	++		++++	+		+++	-	+++
Internet access per 100 inhabitants	---		---	----	-		----	+++		-	----		-		+++		-		-	---	--	---	++	---
High-technology trade per capita in	++	+++	+				+++	---	-	++	++	---		+++					++			+++		

* Malta, Cyprus, Luxemburg were left out in the analysis.

Notations same as in table 1

Source: own calculations based on Eurostat data.

As it results from the above table (table 2), in the majority of researched European Union economies there is a strong positive correlation (the correlation coefficient >0,9) between the R&D expenditures per capita and the remaining variables characterizing knowledge –based economy. It concerns particularly the following countries: the Czech Republic, Slovakia, Germany, Italy, Estonia, Spain, Ireland, Lithuania, Slovenia, Hungary, Latvia, Romania, Greece, Finland and Austria.

Whereas Poland is in the group of countries in which this tendency is not too clear regarding the majority of variables. To this group also belong the following countries: Belgium, France and Great Britain. In case of Poland the principal tendencies can be characterized in the following way:

a) a very strong and statistically significant correlation concerns only the relation between R&D expenditures per capita and the share of R&D expenditures financed by industry in the total of expenditures (r=0,916);
b) a strong positive correlation occurs between R&D expenditures per capita and the share of employed persons in high- and medium – high technology manufacturing sectors in the total of employed persons (r=0,880), the share of 4-year- olds in education (r=0,871) and the number of science and technology graduates aged 20-29 per 1000 persons (r=0,822) and also the number of mobile phone subscriptions per 100 inhabitants (r=0,793), the share of human resources in science and technology in the total of workforce (r=0,773), the share of employed people in knowledge intensive service sectors in the total of employed persons (r=0,755) and the number of years of education – school expectancy(r=0,712);
c) a strong negative and statistically essential correlation occurs between the R&D expenditures per capita and the number of foreign languages per pupil (r= - 0,865) and the participation in education (r=- 0,873).

In the case of remaining variables R&D expenditures per capita correlate in the statistically insignificant degree. The statistically insignificant, and moreover negative, connection between R&D expenditures per capita and the share of R&D expenditures in GDP is surprising. In the absolute approach R&D expenditures per capita actually increase (in comparison with the year 2000 there was a growth of about a half [3]), however, in spite of the high rate of GDP growth in Poland, the share of these expenditures in GDP decreased in recent years (in 2007 this indicator amounted only to the level of about 0,56%), comparable with

[3] In 2000 the R&D expenditures per capita amounted in Poland to 31 euro and in 2007 rose to 46, 3 euro. See: Eurostat.

Slovakia and Bulgaria, and more than 7 times lower in comparison with Sweden or Finland).

The conducted analysis of correlations of the share of R&D expenditures in GDP and R&D expenditures per capita with the remaining variables describing knowledge–based economy leads to the conclusion that a group of economies may be distinguished in which both the share of R&D expenditures in GDP and R&D expenditures per capita are strongly positively correlated with the remaining variables characterizing knowledge–based economy. To this group belong: the Czech Republic, Estonia, Lithuania, Romania and Austria. Poland, however, belongs to the group of economies in which the analyzed relations are rather weak.

4. Estimation of correlative connections between characteristics of knowledge–based economy and basic macroeconomic variables in the European Union countries

Besides the analyses of correlations between variables describing knowledge-based economy, an attempt was undertaken to study the impact of two variables describing knowledge–based economy i.e. the share of R&D expenditures in GDP and R&D expenditures per capita on basic macroeconomic indicators. These correlations are shown in table 3.

Table 3. Correlation between the share of R&D expenditures in GDP and R&D expenditures per capita and basic macroeconomic indicators in the European Union countries* in the years 2000-2007

	AT	B	BLG	CZ	DN	EST	FL	F	EL	ES	NL	IRL	LIT	LTV	D	PL	PT	RU	SLK	SLV	SE	HU	UK	IT
the share of R&D expenditures in GDP																								
Total investment as a percentage of GDP	--			----		+++		---		++++		++++	++++	++++		++		++++					+++	+++
Public investment as a percentage of GDP	---			++				----		++++			+++	+++		-	--	++++	+++			++		
GDP per capita in PPS (EU27=100)	--	+		+++	--	++++		+++	--	++++		++++	++++	+++	--			+++	----			+		----
Growth rate of real GDP per inhabitant (%)				+++										++++					----					
Labour productivity per hour worked (GDP In PPS EU15=100)				+++	-	++++		++	--	++++	-	+++	++++	+++	+	-	++	+++	----		----	++		----
General government gross fixed capital formation (as a percentage of GDP)	---			++				----		++++			+++	+++		-	--	++++	+++			++		
GDP growth rate				++++										++++					----	+				
Labour productivity per person employed (EU27=100)	-			+++	-	++++			--			+++	++++	+++		--	+++	++++	----		--	++		----
Employment rate	+					++++				++++	-	++++	+++	+++					--	+				++++
Business investment as a percentage of GDP				---		+++		--	-	++++	---	++++	++++	+++				++++				---	++	
GDP per capita at current prices	++++	-		++++		++++	++	--		++++	---	++++	++++	+++	++		+++	++++	----		---	+	+++	++++

R&D expenditures per capita																								
Total investment as a percentage of GDP	-	+	++++	----		+++		++		++++		+++	++++	++++			-	++++			+++		+++	+++
Public investment as a percentage of GDP	---	-	+	++					---	++++			++++	++++	-	+	---	++++	---	+++	+			
GDP per capita in PPS (EU27=100)	--	---	++++	++++	----	++++		---	+++	++++		++++	++++	++++	--	++		++++	++++	+++		+++		----
Growth rate of real GDP per inhabitant (%)				+++								-		+++					++++	+++		--		
Labour productivity per hour worked (GDP In PPS EU15=100)		---	++++	+++	---	++++		++		++++	+	+++	++++	++++	+		++	+++	++++			+++ +		----
General government gross fixed capital formation (as a percentage of GDP)	---	-	+	++					---	++++			++++	++++	-	+	---	++++	---	+++				
GDP growth rate			++	+++										+++					++++	+++		--		--
Labour productivity per person employed (EU27=100)	-	---	+++	++++	---	++++			+			++++	++++	++++			+++	++++	++++	+++		+++		----
Employment rate	++	+++	++++			++++	+++	+++	++++	++++		++++	++++	++++	+++	+++			++++	++++		+++		++++
Business investment as a percentage of GDP		+	++++	----	++	++		+	++	++++		++	++++	+++				++++			+++	---	++	
GDP per capita at current prices	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++++	++	++++	++++	++++	++++	+++	+++ +	+++	++++

* Malta, Cyprus, Luxemburg were left out in the analysis.

Notations same as in table 1

Source: own calculations based on Eurostat data.

The analysis of the data presented in table 3 leads to the conclusion that the strongest positive correlation (the correlation coefficient higher than 0,9) between the two analyzed variables describing knowledge–based economy (the share of R&D expenditures in GDP and R&D expenditures per capita) and macroeconomic indicators appears in case of Latvia – the increase in the share of R&D expenditures in GDP and R&D expenditures per capita causes statistically significant and very strong growth of all analyzed macroeconomic variables in this country. A similar situation is in case of Lithuania. It shows a strong connection between economic development in these two Baltic countries with development of knowledge–based economy, especially with the level of innovativeness measured by R&D expenditures. The positive direction of the discussed relations is worth emphasizing as it confirms a positive influence of knowledge–based economy on development of these two dynamically making up for the economic distance countries (to compare, in 2000 in relation to the average of the 27 EU-countries, GDP in Latvia amounted hardly to 36,7%, while in 2007 it was already 57,9%; also in case of Lithuania there appeared a rise of GDP from 41,5% in 2000 to 59,5% in 2007 – table 4).

The comparison of changes occurring in R&D activity and GDP in relation to the Union average in Lithuania, Latvia and Poland places our country far behind them (table 4). While in Poland R&D expenditures (measured by the share in GDP) decreased, they increased both in Lithuania and Latvia – in the period of 8 years about 40%. As far as expenditures per capita are concerned, the rise of them was much lower in Poland. As it results from the data presented in table 4, the dynamic growth of R&D expenditures in Latvia and Lithuania caused a faster growth of GDP per capita in these countries that in 2000 had noted its lower level than Poland.

Table 4. R&D expenditures and GDP in the selected European Union countries in the years 2000-2007

Years	R&D expenditures in GDP in %			R&D expenditures per capita			GDP per capita UE27=100		
	Poland	Latvia	Lithuania	Poland	Latvia	Lithuania	Poland	Latvia	Lithuania
2000	0,64	0,44	0,59	31,0	15,8	20,8	48,2	36,7	39,3
2001	0,62	0,41	0,67	34,6	16,0	26,2	47,6	38,7	41,5
2002	0,56	0,42	0,66	30,7	17,7	28,7	48,3	41,2	44,1
2003	0,54	0,38	0,67	27,1	16,2	31,9	48,9	43,3	49,1
2004	0,56	0,42	0,75	29,8	20,1	39,7	50,6	45,7	50,5
2005	0,57	0,56	0,75	36,3	31,5	45,8	51,3	48,6	52,9
2006	0,56	0,70	0,79	39,6	49,0	56,0	52,3	52,5	55,5
2007	0,56	0,63	0,82	46,3	55,1	68,7	53,7	57,9	59,5

Source: Eurostat.

On the basis of the so far conducted considerations the appearance of clear regularity can be stated – the influence of knowledge–based economy on economic development of the country is especially clearly seen in case of the new member countries. These countries make up for the civilization distance in relation to the "old" Union countries, thus the inflow of resources on innovations makes economic development in these countries more and more dynamic. Among the 15 "old" EU member countries a similar situation takes place in Ireland and Spain while the detailed analysis for the 12 new members shows that among these countries Bulgaria, Slovenia and Poland take the least advantage of knowledge–based economy development. However, taking into consideration the degree of knowledge–based economy development, such a result should not surprise.

It is worth emphasizing that in a few countries there is a strong positive correlation (the correlation coefficient>0,9) between one of the analyzed variables of knowledge–based economy, i.e. R&D expenditures per capita and the majority of the researched macroeconomic variables. To such countries belong: Bulgaria, Slovenia and Slovakia.

On the other hand in countries of a high degree of advancement in knowledge–based economy, eg. Sweden, Finland, Holland and Great Britain these variables affect basic macroeconomic indicators in a marginal degree.

Moreover, in such countries as: Belgium, Greece, Denmark or Austria the discussed correlations are negative – the increase in the share of R&D expenditures in GDP and R&D expenditures per capita is connected with a drop in basic macroeconomic variables.

As far as Poland is concerned it should be noted that the analyzed correlations are weak, same as in case of relations between variables describing knowledge-based economy. Thus a decreasing share of R&D expenditures in GDP causes a significant (in the statistical meaning) drop in the share of complete investments in GDP, an increase of work efficiency per person in relation to the Union average, an increase in the share of public investments in GDP, an increase of work efficiency per hour in relation to the Union average for the "old" countries of the EU as well as an increase in government`s share of total fixed capital formation in GDP. In turn growing R&D expenditures per capita cause an essential rise of the employment rate (the correlation coefficient-(0,8;0,9)), an increase in GDP per capita in market prices, in GDP per capita (PPS EU27=100), in the share of public investments in GDP and an increase in general government gross fixed capital formation expressed as a percentage of GDP.

In the context of the so far conducted considerations a worrying in the Polish economy decrease in the share of R&D expenditures in GDP should be shown. As far as R&D expenditures per capita are concerned, it should be emphasized that there appears in Poland a statistically meaningful and positive correlation between this variable describing knowledge-based economy and some of macroeconomic indicators, although in the majority of cases it is weak (the correlation coefficient – (0,7;0.8)).

5. Concluding remarks

The analysis of correlations between variables describing knowledge-based economy and basic macroeconomic indicators in the countries of the European Union lets formulate the conclusion that in many economies these variables are strongly positively combined which may prove a high degree of cohesion of economic policy in these countries. Poland does not belong to the mentioned group of countries, as it is characterized by the low level of R&D expenditures in GDP and per capita (moreover the share of R&D expenditures in GDP has been decreasing in recent years), the low level of positive correlation both between the share of R&D expenditures in GDP and R&D expenditures per capita and the remaining variables of knowledge–based economy as well as between those expenditures and macroeconomic indicators.

Thus the argument seems plausible that the conducted innovation policy is not cohesive and does not influence significantly on basic macroeconomic categories, and the Polish economy in a small degree takes advantage of possibilities brought by development of innovativeness. It is well known that the domestic R&D expenditures in relation to GDP ranging on the level below 1% (in Poland in 2007 – about 0,57% of GDP) threaten in a long period with weakening of driving force of economic development and social progress. Moreover, it is obvious that these expenditures are slightly converted into effects, occurring in the form of innovative solutions applied in practice. It is evidenced among others by the share of development activity (closeness to market), in Poland amounting to ca 38%, so lower than in many countries of the European Union. The following cause of such weak impact of R&D expenditures on the Polish economy is financing overbalance of R&D activity from budget resources and a relatively small share of enterprises in this financing (Piech 2006; Zienkowski 2004).

To sum up it should be stated that the principal issue is giving clear priority in economic policy to R&D expenditures financed both by the state budget and from resources belonging to enterprises as well as working out and conducting by the state cohesive and active innovative policy coordinated with economic policy.

References

European Innovation Scoreboard 2008 (2009), Comparative Analysis of Innovation Performance, European Commission, Enterprise and Industry, January

European Innovation Scoreboard 2007 (2008), Comparative Analysis of Innovation Performance, Maastricht Economic Research Institute on Innovation and Technology (MERIT) and the Joint Research Centre (Institute for the Protection and Security of the Citizen) of the European Commission

Foray D. (2000), *Economics of Knowledge*, The MIT Press, Cambridge, Massachusetts, London, England

Miedziński M. (2001), *Koordynacja procesów innowacji na przykładzie polskiego województwa*, [in:] *Gospodarka oparta na wiedzy* (2001), Wyzwanie dla Polski XXI w., KBN, Warszawa

Neef D., Siesfeld G. A, Cefola J. (eds.) (1998), *The Economic Impact of Knowledge*, Butterworth Heinemann, Boston

Piech K. (2006), *Rozwój gospodarek wiedzy w Europie Środkowo-Wschodniej w kontekście Strategii Lizbońskiej*, [in:] E. Okoń-Horodyńska, K. Piech (ed.) *Unia Europejska w kontekście*

Strategii Lizbońskiej oraz gospodarki i społeczeństwa wiedzy w Polsce, (2006), Instytut Wiedzy i Innowacji, Warszawa

Rodrigues J. M. (2003), *European Policies for a Knowledge Economy*, Edward Elgar, Cheltenham, UK. Northampton, MA, USA

Rooney D, Hearn G., Ninan A. (2005), *Handbook on the Knowledge Economy*, Edward Elgar, Cheltenham, UK. Northampton, MA, USA

Science and Technology in 2007 (2008), Central Statistical Office, Warsaw

Smith K. (2002), *What is the Knowledge Economy. Knowledge Intensity and Distributed Bases*, Discussion Paper, series 2002-6, The UN University, INTECH, Maastricht

Stec M. (2009), *Innowacyjność krajów Unii Europejskiej*, 'Gospodarka Narodowa', Nr 11-12

Stevens C. (1998), *The Knowledge-Driven Economy*, [in:] D. Neef, Butterworth-Heinemann (ed.) *The Knowledge Economy*, Boston, Oxford, Johannesburg, Melbourne, New Delhi, Singapore,

The Knowledge-Based Economy, OECD, Paris 1996

Zienkowski L. (2004), *Czy polska polityka makroekonomiczna zawiera paradygmat wzrostu innowacyjności gospodarki?*, [in:] Okoń-Horodyńska E. (ed.) *Rola polskiej nauki we wzroście innowacyjności gospodarki*, (2004), Polskie Towarzystwo Ekonomiczne, Warszawa

Żelazny R. (2006), *Gospodarka oparta na wiedzy w Polsce – diagnoza stanu według Knowledge Assessment Methodology 2006*, [in:] Okoń-Horodyńska E., K. Piech K. (eds.) (2006) *Unia Europejska w kontekście Strategii Lizbońskiej oraz gospodarki i społeczeństwa wiedzy w Polsce*, Instytut Wiedzy i Innowacji, Warszawa

Streszczenie

ANALIZA WPŁYWU GOSPODARKI OPARTEJ NA WIEDZY NA ROZWÓJ EKONOMICZNY KRAJÓW UNII EUROPEJSKIEJ

Kierunki przemian w gospodarce światowej, zachodzących w ostatnich latach, wskazują na przechodzenie od gospodarki ery industrialnej, opartej na ekonomii skali, do gospodarki wiedzochłonnej, opartej na potencjale technologicznym i innowacyjnym. Zwiększanie inwestycji w środki trwałe nie jest już wystarczającym sposobem na zapewnienie trwałego wzrostu gospodarczego. Czynnikami decydującymi o rozwoju stają się działalność badawczo - rozwojowa (B+R), działalność innowacyjna oraz tzw. kapitał ludzki. Za istotną determinantę poziomu innowacyjności poszczególnych gospodarek uznaje się nakłady na badania i rozwój, przeznaczane na prowadzenie badań podstawowych, stosowanych i prac rozwojowych, jak i efekty tych badań, występujące w postaci innowacyjnych rozwiązań stosowanych w praktyce.

Celem artykułu jest analiza związków korelacyjnych między dwiema głównymi zmiennymi opisującymi gospodarkę opartą na wiedzy, tj. między udziałem nakładów na B+R w PKB i nakładami na B+R per capita, a pozostałymi charakterystykami GOW, jak również ocena wpływu tych dwu zmiennych na podstawowe wielkości makroekonomiczne w krajach Unii Europejskiej, a co za tym idzie analiza wpływu gospodarki opartej na wiedzy na rozwój gospodarczy tych krajów.