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THE EUROPEAN UNION IN GLOBAL RESEARCH AND DEVELOPMENT: THE BALANCE AND PROSPECTS[1]

INTRODUCTION

Globalisation is marked by a sharp acceleration of technological progress, with a key role played by expenditure on R&D aimed at creating new knowledge and technology. The very process of globalisation has led to developing the concept of knowledge-based economy or knowledge economy where the fundamental production factor is knowledge and a country's endowment with knowledge determines its position in the world economy[2]. Thus, knowledge has incompara-

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[2] L. Leydesdorff, *The Knowledge-Based Economy and the Triple Helix Model*, „Annual Review of Information Science and Technology" 2010, No 44, pp. 367-417; B. Godin, *The Knowledge Based Economy: Conceptual Framework or Buzzword?* „Journal of Technology Transfer" 2006, No 31(1), pp. 17-30; J.H. Dunning (Eds.), *Regions, globalization, and the knowledge-based economy*, Oxford 2002; D. Archibugi, B.-A. Lundvall (Eds.), *The Globalizing Learning Economy*, Oxford 2001.

bly gained in importance and become intensified by increasing expenditure on research and development on an unprecedented scale[3]. The greatest dynamics has been seen since the mid-1990s.

In terms of global R&D, for decades the European Union had ranked second in the world after the United States and its position seemed not to be in jeopardy. Due to changes caused by globalisation, however, developing economies joined global research and development, particularly Asian countries led by China. The present structure and pattern of the world's R&D have been undergoing considerable transformation.

This study aims to determine the role played by the European Union in global R&D in the context of changes in the world pattern and to outline prospects for the European Union to maintain its position in fast-growing R&D.

The main research issue of this investigation is the comparative analysis of the R&D potential of the European Union against the backdrop of the USA and the Asian centre in conditions of a new arrangement forming in global R&D. As a result of analyses carried out, problem areas will be identified in the EU's research and development and directions for the future will be outlined.

This study is based on the following research hypotheses:

H1: Despite its significant role in global research and development, the European Union has been experiencing a weakening position in the new global arrangement.

H2: R&D in the European Union has been lagging behind changes in global R&D.

H3: The weaknesses of EU R&D result from internal structural causes in the Community rather than from the emergence of the new Asian centre.

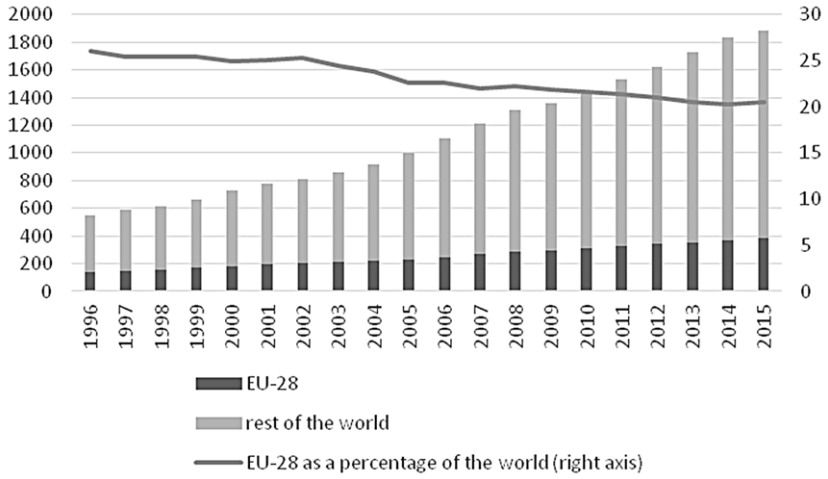
The arguments are grouped in three main parts. The first section focuses on emphasising the EU's role in the new global R&D pattern and analysing the potential of the EU against the backdrop of the USA and East Asia based on a wide range of absolute and relative indicators. The second part gives insights into problems related to the composition of R&D in the European Union, thus on issues connected with business expenditure on R&D and with intra-EU disproportions between individual Member States. Finally, the third section identifies problem areas in EU R&D and outlines prospects for the future.

THE EU'S ROLE IN THE NEW PATTERN OF GLOBAL R&D

The European Union's expenditure on R&D has been constantly rising (Fig. 1). Although Gross Domestic Expenditure on R&D (GERD) in the EU-28 increased by a factor of 2.7 in 1996-2015 global R&D showed a 3.4-fold growth over the same period. Therefore, the share of the EU-28 in the world's expenditure on R&D gradually declined from 26.1% in 1996 to 20.5% in 2015.

[3] M. Coccia, *Political economy of R&D to support the modern competitiveness of nations and determinants of economic optimization and inertia*, "Technovation" 2012, No 32, pp. 370-379.

Fig. 1. Expenditure on R&D in the EU-28 in comparison with the rest of the world (billion PPP USD, current prices)



Source: Author's calculations based on OECD, *Main Science and Technology Indicators*. http://han.uek.krakow.pl/han/oecd/stats.oecd.org/BrandedView.aspx?oecd_bv_id=strd-data-en&doi=data-00182-en (21.08.2017); UNESCO, *Science, Technology and Innovation*. http://data.uis.unesco.org/ (24.08.2017).

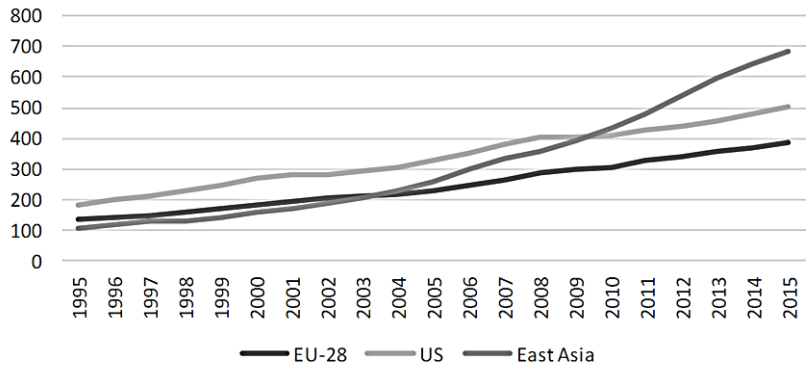
It is indicated that one reason for the weakening position of the European Union in global R&D is undoubtedly the process of R&D decentralisation, observed since the 1990s and reflected in the involvement in R&D of other countries in addition to the traditional centres in the Triad. It is worth mentioning that until the end the 1980s investment in R&D was basically made by five countries, namely the USA, Japan, Germany, France and the United Kingdom. The five economies accounted for approx. 85% of the world's expenditure on R&D, with a distinct leading position of the United States where investment in R&D was higher than the overall expenditure of the other four combined. After the mid-1990s, two Asian countries joined the above-mentioned top performers: South Korea (from 1995) and China (from 1997). Since then, particularly China has been rapidly growing in importance; in 2004, it ranked third (behind the USA and Japan) in terms of expenditure on R&D, whereas it has continuously strengthened its position as the world's vice-leader since 2009. Moreover, South Korea has ranked fifth worldwide since 2010. The new players in global R&D are mostly developing countries[4].Obviously, the decentralisation of research and development has primarily resulted in the successes of China and South Korea, both among the

[4] OECD, *OECD Science, Technology and Industry Scoreboard 2011: Innovation and Growth in Knowledge Economies*, Paris 2011; OECD, *Perspectives on global development 2010: shifting wealth,* Paris 2010, pp. 118--121; H.S. Kehal, V.P. Singh, *Outsourcing and Offshoring In the 21st Century: a socio-economic perspective.* Hershey London Melbourne Singapore 2006, pp. 432-446; UNCTAD, *The impact of FDI on development: globalization of R&D by transnational corporations and implications for developing countries*, Geneva 2005, pp. 3-4, UNCTAD, *Survey on the internationalization of R&D*, New York and Geneva 2005, pp. 7-10.

world's top performers in the current pattern[5]. A number of publications have addressed the decentralisation of global research and development as an opportunity for developing countries to integrate into the global mechanism of knowledge creation by enhancing R&D activities, also induced by transnational corporations[6].

The past two decades have seen distinct changes in the architecture of global research and development, marked by the emergence and dynamic strengthening of East Asia's position. The traditional Asian leader for decades, i.e. Japan, has been joined primarily by China and South Korea as well as by Taiwan, together forming the main global R&D centre in terms of expenditure on R&D (Fig. 2). As early as 2004, the combined expenditure on R&D of the above-mentioned Asian centre exceeded the respective figure for the EU-28; fuelled by buoyant growth in R&D in China and South Korea, it outperformed the United States with regard to expenditure on R&D in 2010. Furthermore, since that year, East Asia has been clearly strengthening its position, leaving behind the USA and the European Union whose expenditure on R&D has increased but definitely less dynamically. In 2015, R&D in the four economies of the Asian centre (China, Japan, South Korea and Taiwan) accounted for USD 686.4 billion, whereas the United States and the EU-28 invested USD 502.9 billion and USD 386.5 billion respectively.

Fig. 2. GERD of the three centres of global R&D (billion PPP USD)



Source: Author's calculations based on OECD, *Main Science and Technology Indicators...*

[5] L.Y.Y. Lu, T.M. Chen, *Technology Strategy of R&D Internationalization: An Empirical Study from a Developing Country*, in: W: F. Betz (eds.), *Creating and Managing a Technology Economy*, Singapore 2012, pp. 81-108; C. Hiratuka, *Transnational Corporations and Internationalization of the Research and Development Activities in Developing Countries: The Relative Importance of Affiliates in Asia and Latin America*, in: A. Deshpande (eds.), *Capital without Borders: Challenges to Development*, India 2011, pp. 147-164.

[6] P. Moncada-Paterno-Castello, M.Vivarelli, P. Voigt, *Drivers and impacts in the globalization of corporate R&D: an introduction based on the European experience.*"Industrial and Corporate Change" 2011, No 20/2, pp. 585–603; UNCTAD, *World investment prospects survey 2009-2011*, New York and Geneva 2009, pp. 29-30; UNCTAD, *Globalization of R&D and developing countries*, New York and Geneva 2005, pp. 97-103.

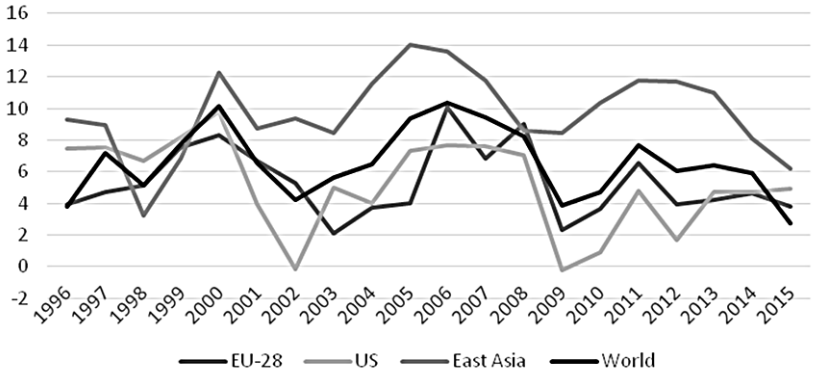
Therefore, it can be clearly concluded that the 2010s have witnessed major changes in the system of global expenditure on R&D; in 2015, the Asian centre represented 36.5% of the world's GERD, the EU-28 accounted for 20.5% and the United States for 26.7%, whereas until the 1990s the USA had invested more than 40% of global R&D. Paradoxically, though, the aforementioned decentralisation of global research and development is still accompanied by strong concentration[7] as the combined proportion of the three centres in global expenditure on R&D was 83.7% in 2015.

Since 2009, the Asian centre has been led by China whose spectacular acceleration of technological development allowed it to achieve the 2015 share in the world's expenditure on R&D at 21.7% (USD 408.8 billion). This centre has been considerably reinforced by Japan; although the growth rate of its expenditure on R&D is low the absolute value is still substantial (USD 170 billion in 2015). As regards South Korea, over the past decade it has doubled its expenditure on R&D, with the 2015 figure at USD 74.1 billion. Relatively the weakest player in the Asian centre is Taiwan, with fast-growing R&D since the mid-1990s (usually at an annual rate exceeding 10%); in 2015, its expenditure was USD 33.6 billion. However, the inclusion of Taiwan in the Asian centre is justified, on the one hand, by its geographical location and, on the other hand, by the structural similarity of Taiwanese research and development to R&D activities in the other three East Asian economies.

When analysed in terms of growth in expenditure on R&D, the European Union shows a relatively weakening position in the world's R&D (Fig. 3). In the period covered, its expenditure on R&D grew at a lower rate than in the world economy as a whole (with similar trends observed for the USA), whereas East Asia boasted spectacular results, with the annual average growth rate of 9.7%. It is worth noting that the result was pushed down by the situation in Japan (the annual average growth rate of 4.1%), whereas China increased its expenditure on R&D by an average of approx. 19% annually.

[7] Odrobina A.,*Changes in Global Research and Development: Decentralisation or a New Concentration? "*Central European Review of Economics & Finance" 2015, no. 4 (10), pp. 19-33.

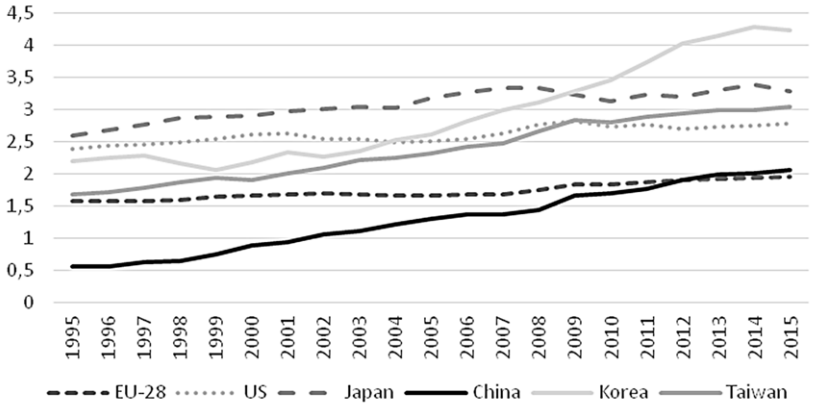
Fig. 3. Growth rate of expenditure on R&D (%)



Source: Author's calculations based on OECD, *Main Science and Technology Indicators...* .

An analysis of the share of expenditure on R&D in GDP confirms the weakness of the EU-28 in comparison with the two leading global centres (Fig. 4). Among the economies under examination, the EU-28 is characterised by the lowest share of R&D in GDP (1.96% in 2015), with only minor progress made over two decades as in 1995 the proportion was 1.59%. The US economy was similarly stagnant in this respect although it had a share around 1 percentage point higher than the EU-28 figure. At the same time, the East Asian economies have shown high shares of GERD in GDP; China exceeded the EU's proportion in 2013 and spent 2.1% of GDP on R&D in 2015. Apart from China, South Korea and Taiwan have made remarkable progress as well (4.23% and 3.1%, respectively, in 2015). In turn, for two decades Japan achieved a high share of GERD in GDP, even if markedly fluctuating, ranging from 2.6% (1995) to 3.4% (2014).

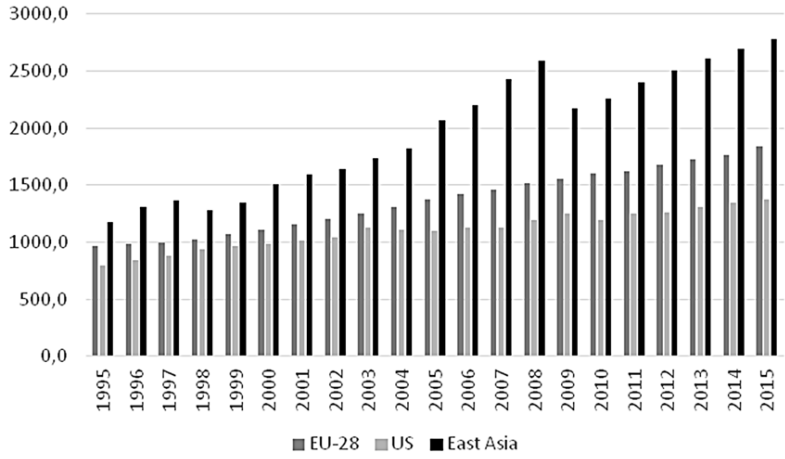
Fig. 4. GERD as a share of GDP (%)



Source: Author's study based on OECD, *Main Science and Technology Indicators...* .

Research and development potential is closely connected with access to skilled labour and talents. An examination of the number of researchers (Fig. 5) shows marked domination of East Asia, with 2.8 million researchers in 2015. Nevertheless, it is worth noting that the European Union had greater potential in this respect than the USA (1.8 million versus 1.4 million in 2015) and nearly doubled the number of researchers in 1995–2015, whereas the USA experienced a weaker rise in the number of researchers. Bearing in mind the above, consideration should be given to the efficiency of the utilisation of human capital in R&D in the European Union if, having greater human potential than the USA, it performs distinctly worse, e.g. in terms of expenditure on R&D.

Fig. 5. Number of researchers (thousand FTAs)



Source: Author's study based on OECD, *Main Science and Technology Indicators...* .

One measure of the output of R&D resulting in new knowledge and technology is the number of patent applications for the legal protection of intellectual property. On account of the nature of this investigation, the analysis covered two types of global patents, namely triadic patent families and international patents, with applications filed in accordance with the international procedure adopted under the Patent Cooperation Treaty (PCT).

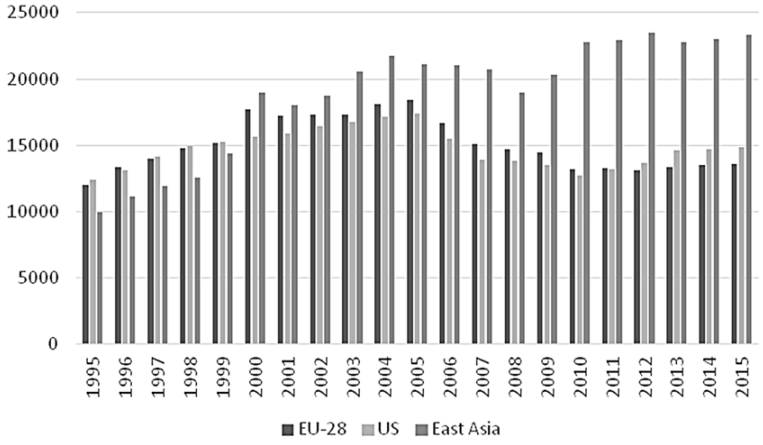
The European Union is a major player in the creation of new knowledge and technology, as reflected in the number of both triadic patent families and PCT patents (Figures 6 and 7). Until 2011, the number of the EU's triadic patent families was even higher than the respective US figure but since 2012 the US advantage over the EU has been growing. In 2015, EU and US entities obtained 13,600 and 14,900 triadic patent families respectively. It must be emphasised that since 2000 the leader in terms of the number of triadic patent families has been East Asia, continuously dominated by Japan; since 2000, Japan alone has obtained more triadic patent families than the EU and USA[8]. In this respect, the

[8] OECD, *Main Science and Technology Indicators...;* WIPO, *WIPO statistics database*. https://www3.wipo.int/

Asian centre is additionally strengthened by South Korea and by ever-more active participation of Chinese entities in obtaining patents. As a consequence, in 2015 East Asia accounted for 23,300 triadic patent families. The aforementioned situation results in significant gaps of both the European Union and the USA to the Asian leader.

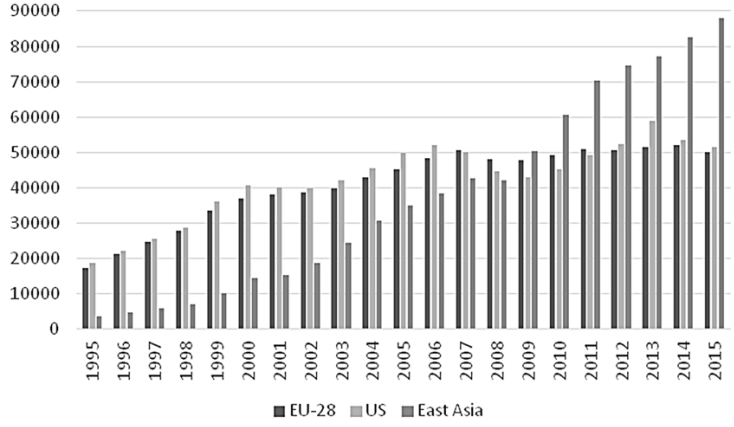
As regards PCT patents, the domination of the European Union and of the USA still prevailing in the 2000s was broken in 2010 by East Asia, continuously increasing the number of PCT patents obtained in contrast to limited progress made by the EU and the USA. In 2015, the European Union and the USA had 50,200 and 51,400 PCT patents respectively, whereas East Asia – 87,900.

Fig. 6. Number of triadic patent families



Source: Author's study based on OECD, *Main Science and Technology Indicators*... .

Fig. 6. Number of PCT patents



Source: Author's study based on WIPO, *WIPO statistics database*... .

ipstats/index.htm?tab=patent (20.08.2017).

At present, the strength of East Asia in its patent activities seems unquestionable, which is presumably related to its R&D orientation towards development and certainly constitutes a major driver of the successful performance of the Asian economies due to the ease of knowledge commercialisation[9]. In the case of the European Union, although its position in the number of patents is significant in the global system and essentially comparable to that of the United States there have been symptoms of stagnation since 2010.

ISSUES RELATED TO THE STRUCTURE OF EU R&D

When attempting to explain the position of the European Union in global research and development, it is justified to consider the structure of EU R&D. It seems that issues concerning the structure, thus the characteristics of R&D in the European Union may indicate problem areas posing barriers to maintaining its position in the new global pattern. This investigation covers the structure of financing and performing expenditure on R&D, with a special emphasis on the business sector, and the composition of R&D in the EU by Member State.

The analysis of the structure of financing and of entities engaged in R&D (Figures 8 and 9) clearly demonstrates that in this respect the European Union differs from the other economies. The government plays a major role in expenditure on R&D (32.6%), whereas in the USA its share is 24% and only slightly above 20% in East Asia, with the exception of Japan (15.4%). Although in all the economies the business sector finances the most R&D EU enterprises are relatively the least active in funding R&D, with a mere 54.8% of total expenditure on R&D. It must be pointed out that in this respect the Asian economies rank the highest as their business sectors represent ca. 75% of GERD. In the USA, businesses funded 64.2% of research and development in 2015.

The structure of R&D financing in the EU indicates excessive use of public funds accompanied by a relatively low share of the business sector. Problems which may be caused by such a situation are twofold: on the one hand, issues related to the economic efficiency of public spending; on the other hand, those connected with weaknesses of EU undertakings: their insufficient engagement in R&D financing involves a risk of deteriorating competitiveness towards Asian and US corporations.

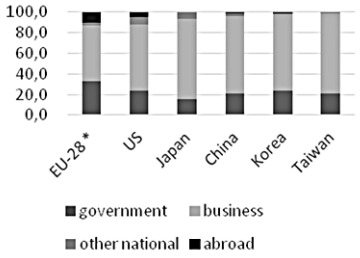
Unfortunately, the composition of entities performing R&D also points to weaknesses of EU enterprises since they account for 63.6% of total expenditure on R&D, whereas higher education establishments play an important role (23.2%). The share of the business sector is much higher in the other economies, with East Asia at the forefront (above 77%), led by Japan (78.5%). In the USA, enterprises represent 71.5% of total expenditure on research and development. At the same time, universities in the Asian centre perform less than 10% of GERD, apart

[9] A. Odrobina, *Stany Zjednoczone versus Chiny: rywalizacja o prymat w globalnej działalności badawczo-rozwojowej*. "HoryzontyPolityki"2017, No *8*(23), pp. 101-120; C. Huang, N. Sharif, *Global Technology Leadership: The Case of China*, "HKUST IEMS Working Paper" 2015*,* No 11, February, pp. 1-36.

from Japan (12.3%), showing similarity in this respect to the USA (13.2%). As regards the government sector, in all the economies its share is around a dozen per cent.

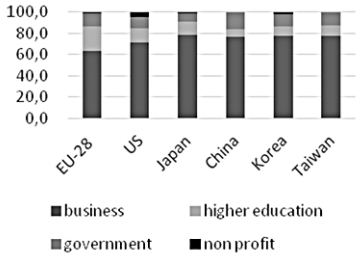
*Data for 2014

Fig. 8. Financing of R&D in 2015 (%)



Source: OECD, *Main Science....*

Fig. 9. Entities performing R&D in 2015 (%)

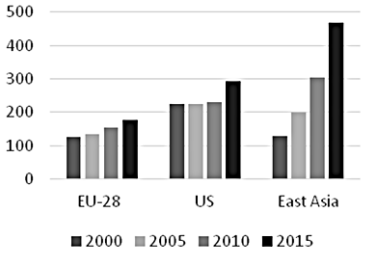


Source: OECD, *Main Science...* .

Business activity is a very important issue in research and development. It naturally follows from the fact that enterprises invest in development-oriented or applied R&D, thus in such knowledge as may be commercialised as soon as possible, expecting an improved competitive position. Knowledge implemented in the economy benefits not only the undertaking having created the knowledge but also, through synergy effects, other enterprises and the economy as a whole. Therefore, expenditure on R&D performed by the business sector seems to be more efficient economically.

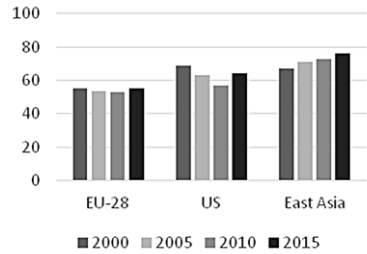
However, in absolute terms, despite a continuing rise from 2000, business expenditure on R&D (BERD) in the EU significantly lags behind the USA and East Asia (Fig. 10). In 2000-2015, EU undertakings increased BERD by a factor of 1.4, whereas in the Asian centre it went up 3.7 times, mostly pushed up by Chinese enterprises, raising East Asian business expenditure on R&D to USD 468 billion in 2015. US undertakings whose R&D, after years of stagnation, began to rise again in 2010 performed expenditure of USD 292 billion in 2015. Compared to the above, the performance of EU firms with USD 176 billion in 2015 seems rather modest. It confirms the earlier diagnosis of weaknesses of R&D activities pursued by EU undertakings, also in relative terms (Fig. 11). EU businesses are in apparent stagnation, failing to maintain the growth rate of total expenditure on R&D in the EU. A similar situation concerns US companies as well. Enterprises of the Asian centre clearly lead the way, steadily increasing their expenditure on R&D at a rate higher than that of total expenditure on research and development in East Asia as a whole.

Fig. 10. BERD (USD billion)



Source: OECD, *Main Science...* .

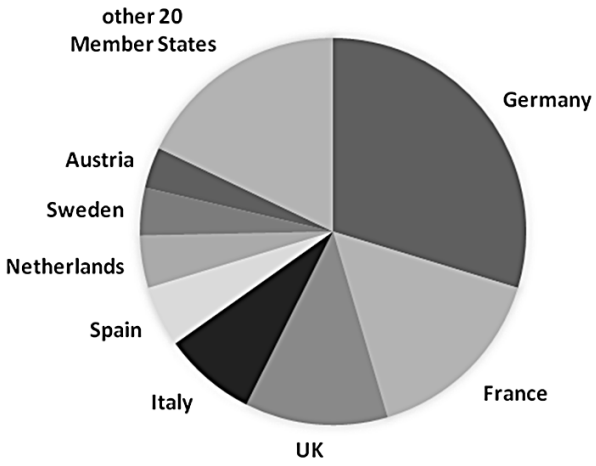
Fig. 11. BERD as a share of GERD (%)



Source: OECD, *Main Science....*

When analysing the structure of EU research and development, it is impossible not to mention considerable disproportions between individual EU Member States in this regard. It seems that this may pose a major problem since, in fact, EU R&D is essentially based on three countries: Germany, France and the United Kingdom, accounting for a total of 57.4% of expenditure on R&D in the European Union in 2015 (Fig. 12). Germany alone, as the EU leader, performed 30% of EU R&D. The eight Member States indicated in Fig. 12 represented 82.1% of EU R&D, which means that the other 20 Member States merely performed 17.9% of the EU-28 GERD.

Fig. 12. Structure of GERD in the European Union in 2015

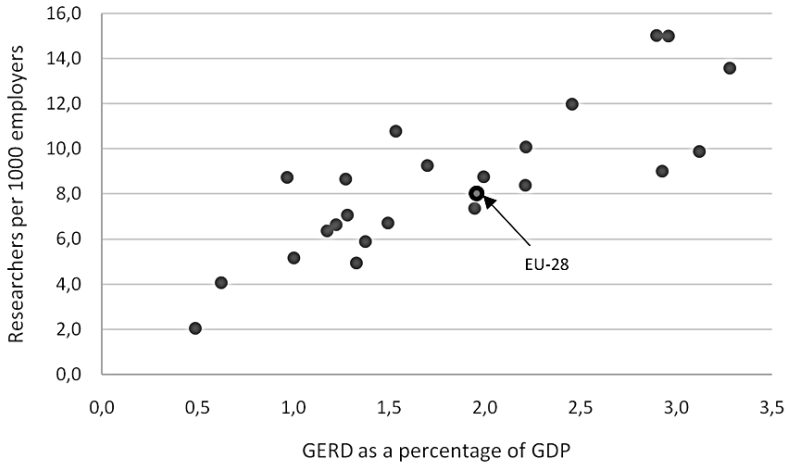


Source: Author's study based on OECD, *Main Science...* .

Obviously, the group in question also includes small economies whose potential shows very limited capabilities to increase expenditure on R&D; nevertheless, the problem of disparities between Member States remains a fact, not resulting solely from the size of economies. It is reflected in relative indicators of the share of expenditure on R&D in GDP and of the number of researchers

per 1,000 persons employed presented in Fig. 13. On the one hand, in terms of the above-mentioned indicators certain Member States rank among the world's top performers in knowledge economy, namely Sweden (3.3% of GDP and 13.6 researchers per 1,000 employers), Austria (3.1% of GDP and 9.9 researchers per 1,000 employers), Denmark (3.0% of GDP and 15 researchers), Finland (2.9% and 15 researchers) and Germany (2.9% and 9 researchers). On the other hand, the EU also includes Member States such as Romania and Latvia, with shares of expenditure on R&D even below 1% of GDP and very modest relative numbers of researchers. However, in the largest group of Member States the R&D share in GDP ranges from 1% to 2% and the number of researchers is below 10 per 1,000 persons employed.

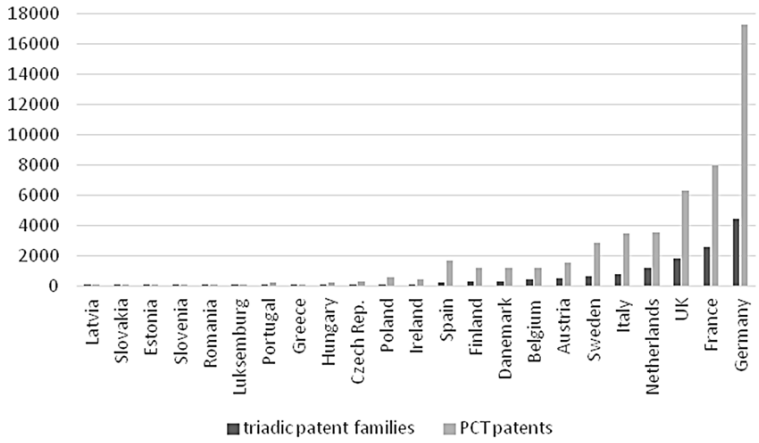
Fig. 13. Relative R&D indicators in the EU Member States in 2015



Source: Author's study based on OECD, *Main Science...* .

In addition, the above conclusions are corroborated by an examination of the number of patents obtained by EU Member States (Fig. 14). With regard to both triadic patent families and PCT patents, there is a clear domination of countries characterised by the highest absolute expenditure on R&D in the EU (Germany, France, the United Kingdom, Italy, Austria, the Netherlands) and Member States with high R&D intensity (Sweden, Denmark, Finland). In the case of triadic patent families, the top eight countries in terms of the number of patents obtained accounted for 90.9% of the total number of patents obtained by the EU in 2015. A similar degree of concentration was observed for PCT patents where the best eight performers obtained 88% of all patents held by entities from the European Union.

Fig. 14. Number of patents in the EU Member States in 2015



Source: Author's study based on OECD, *Main Science...;* WIPO, *WIPO statistics...* .

Intra-EU disproportions certainly present a substantial obstacle to R&D dynamics in the EU as a whole. At the same time, it must be stressed that the EU Member States characterised by limited involvement in R&D might become R&D growth engines with their potential unleashed. But the current situation in EU research and development is strongly determined by the existing disproportions between individual Member States. As a matter of fact, R&D in the European Union is created by several economies, led by Germany and including France, the United Kingdom, Italy, the Netherlands, Sweden and Austria. The share of the other countries can be considered by far insufficient, particularly in the context of the European Union's aspiring to remain a major centre of global R&D.

PROBLEM AREAS IN EU R&D AND POSSIBLE SCENARIOS

When considering problem areas in the European Union's research and development, one may indicate two types thereof, i.e. those resulting from the formation of a new pattern of global R&D and those connected with the structure of EU R&D.

As regards the former, it must be emphasised that they are directly related to the shift of the centre of gravity in global R&D from the USA to East Asia, currently the player to most strongly determine the shape and development directions of the global arrangement. Therefore, the European Union, for decades struggling to catch up with the USA, needed to face the fast-growing East Asian centre, which further exposed the weaknesses of EU R&D. The problem areas are based on the comparison of the EU with the other two global R&D centres, with the following weaknesses of EU R&D to be pointed out:

– a declining share of the EU in global expenditure on R&D,

- a low growth rate of total expenditure on research and development,
- a low share of GERD in GDP,
- underutilised potential of researchers (more numerous than in the USA),
- symptoms of stagnation in obtaining triadic patent families and PCT patents.

The aforementioned weaknesses of EU R&D against the backdrop of the other two centres of the world's R&D point to a real risk of the EU's further diminishing role in global R&D.

As regards problem areas resulting from the structure of EU R&D, those are connected with the EU's internal characteristics of research and development activities, determining the nature, development orientations and potential of R&D in the European Union. Such issues comprise the following:

- overgrown public funding of R&D,
- insufficient engagement of the business sector in R&D financing,
- an unsatisfactory share of enterprises in performing expenditure on R&D,
- an excessive share of the higher education sector in performing R&D,
- strong domination of several countries accompanied by weak R&D sectors in the other economies,
- significant relative disproportions between Member States,
- strong domination of several countries in obtaining patents.

The aforementioned problem areas represent major barriers to greater R&D dynamics in the European Union. It seems vital to increase the involvement of the business sector in the EU as it would allow orientating EU R&D towards development and applied research as well as towards commercialisation, simultaneously strengthening the global competitiveness of EU enterprises.

With regard to the identified weaknesses of the European Union, consideration must be given to its prospects in the context of the new pattern in global R&D. It must be highlighted that the problem of keeping up in R&D was addressed in the 2000 Lisbon Strategy; the intensification of research and development activities was supposed to be the basis for the EU to become the most competitive economy in the world and to overtake the USA by 2010. Setting aside the subsequent development of the Strategy and the non-achievement of its objectives, in its functioning the EU has repeatedly referred to that plan, solely abandoning the unrealistic time horizon[10]. At present, a major strategic plan for the European Union is *Innovation Union*, included in a broader package of the Europe 2020 Flagship Initiatives. *Innovation Union*[11] constitutes the basis for taking action aimed at R&D, identifying challenges and opportunities facing the EU as well as addressing threats to the present position of the European Union in R&D[12].

[10] H. Delanghe, U. Muldur, L. Soete, *European Science and Technology Policy: towards Integration or Fragmentation?*, CheltenhamNorthhampton 2009, pp. 3-27.

[11] Komisja Europejska, *Projekt przewodni strategii Europa 2020. Uniainnowacji*, Bruksela COM (2010)546.

[12] L.Höpker, *The Chances of Success of the Europe 2020 Strategy – An Analysis against the Background of the Lisbon Strategy.* Europa-Kolleg Hamburg, Institute for European Integration, Study Paper No 4/13/ 2013, pp. 1-57.

To recapitulate the above discussion, an attempt was made to outline three R&D scenarios for the European Union: the most likely, optimistic and pessimistic scenarios depending on internal EU conditions and determinants on the part of the two other centres.

In the most likely scenario, it must be assumed that further development of EU R&D activities will follow the existing lines at the current pace. As a result, the EU would be the world's third R&D centre, just as at present. Should there be no unexpected economic and political disturbances, the EU would maintain its position in global R&D but its gap to the USA and East Asia would widen steadily if the two centres should continue to grow as before. The EU would still be attractive to those centres as a partner for mutual cooperation in research and development and as an economy creating knowledge crucial to technological progress.

The optimistic scenario assumes a dynamic acceleration of EU R&D, thus catching up with the USA and East Asia, which would improve the European Union's position in global R&D. Most likely, it would still rank third worldwide in terms of expenditure on R&D but it would be significantly more attractive, therefore oriented towards more intensive cooperation, particularly with East Asia, further stimulating R&D in the EU. For the scenario to materialise, it would be necessary to strongly activate the business sector in R&D and orientate R&D towards commercialisation, with positive spill-over effects on the EU economy as a whole, perhaps also intensifying R&D in other Member States.

As far as the pessimistic scenario is concerned, the European Union's widening gap to the USA and East Asia would severely undermine its role in global R&D against the fast-growing East Asian and US economies. Consequently, a new pattern would emerge, a quasi-duopoly of East Asia and the USA, strongly oriented towards strengthening relations within the arrangement. The EU would remain outside mainstream global R&D and, owing to its clearly weakening position it would lose interest in cooperation with the two strong centres.

CONCLUSIONS

In the new pattern of global R&D in the course of formation, with the largest centre in East Asia, the European Union is the world's third research and development centre after the USA. Its position in the global arrangement seems to be unquestionable, whether in terms of expenditure on R&D, human capital or patent activity. It has also been demonstrated that steady progress in EU research and development can be observed. The emergence of a new leader in global R&D, i.e. the Asian centre, has pushed down relative shares of the European Union, which should not be alarming to a certain degree, but such robust growth in East Asian R&D may give rise to concerns over the EU's ability to maintain its position of a major and attractive centre in the global R&D system.

It can be observed that the pace of desirable changes in the EU is by far insufficient to keep up with dynamic developments in the global pattern, currently under a strong influence of East Asia; therefore, the gap to, especially, the Asian centre but also to the USA, even if to a lesser extent, has been widening. On the basis of the above analysis, it is possible to conclude that it is necessary not only to significantly speed up R&D in the European Union but also to orientate the process accordingly, with a primary focus on activating the business sector. Otherwise, the USA-East Asia arrangement may become so strong that, should the EU's distance to the two centres continue to increase, the European Union might experience certain exclusion.

It must be emphasised that despite the enormous challenge to the European Union, i.e. the emergence of the new and the strongest Asian centre of global R&D, the most essential problem areas result from the structure and characteristics of EU R&D. Firstly, EU research and development is in fact created by several Member States led by Germany, with limited shares of most economies, whereas substantial intra-EU disproportions raise a question whether the European Union should at all be regarded as a single economic organism in the context of R&D. Secondly, analyses of the structure of EU R&D showed insufficient involvement of the business sector in financing and performing expenditure on R&D, which seems to be a major issue and challenge to the EU.

The above considerations allowed corroborating the research hypotheses adopted. Nevertheless, the wide range of subjects prevents an in-depth and exhaustive examination of complex linkages and conditions in the global pattern of R&D. A number of issues will certainly require further investigations in more detail, e.g. possible ways of activating EU enterprises, also through research and development policy tools.

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Summary: This article attempts to determine the position of the European Union in the new global pattern of research and development led by fast-growing East Asia. The essential research issue raised in the paper is a comparative analysis of the R&D potential of the European Union relative to the Asian centre and the USA aimed to identify problems in EU R&D. The article employs two main research tools: a traditional overview of studies in the literature and a comparative analysis.

The examination demonstrates continuing progress in building the R&D potential of the European Union, the third largest global R&D centre. Against the backdrop of East Asia and the USA, however, EU R&D changes definitely too slowly, which results in a widening gap between the EU and, especially, the Asian centre but also the USA. The analysis allows concluding that it is necessary not only to significantly speed up R&D in the European Union but also to orientate the process accordingly, with a primary focus on activating the business sector.

Keywords: R&D, EU, problem areas in EU R&D, comparative analysis, East Asia, scenarios.

UNIA EUROPEJSKA W GLOBALNEJ DZIAŁALNOŚCI BADAWCZO-ROZWOJOWEJ: BILANS I PERSPEKTYWY

Streszczenie: Celem artykułu jest określenie pozycji Unii Europejskiej w nowym globalnym układzie działalności badawczo-rozwojowej, w którym liderem stała się dynamicznie rozwijająca się Azja Wsch. Zasadniczym problemem badawczym opracowania jest analiza porównawcza potencjału R&D Unii Europejskiej względem centrum azjatyckiego i USA, aby w rezultacie zidentyfikować kwestie problemowe w R&D UE. W artykule wykorzystano dwa główne narzędzia badawcze, jakimi są tradycyjne studia literaturowe oraz analiza porównawcza. W wyniku przeprowadzonych analiz wykazano, że widoczny jest stały progres w budowaniu potencjału R&D UniiEuropejskiej, która stanowi trzecie co do wielkości centrum globalnych R&D. Jednak na tle Azji Wsch. i USA tempo zmian w unijnych R&D jest stanowczo za niskie, a w konsekwencji powiększa się dystans UE zwłaszcza do centrum azjatyckiego, ale także i do USA. Na podstawie przeprowadzonych rozważań można wnioskować, że konieczne jest nietylko znaczne przyspieszenie R&D w Unii Europejskiej, ale też odpowiednie ukierunkowanie tego procesu, przede wszystkim w stronę aktywizacji sfery biznesu.

Słowa kluczowe: B+R, UE, obszary problemowe w B+R Unii Europejskiej, analizaporównawcza, AzjaWschodnia, scenariusze.