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Competitive Strategies of Positioning of Countries in Nanotechnology[1]

Конкурентске стратегије позиционирања земаља у нанотехнологији

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Abstract: In the long run, nanotechnology can make revolutionary breakthroughs that will have profound economic consequences. Therefore, the projection of competition and positioning strategies of countries is of great importance for the evaluation of the role of individual countries in nanotechnology in the future. The aim of this paper is to determine how the observed countries - The U.S., Canada, Germany, the UK, France, the Netherlands, Sweden, Switzerland, Italy, Russia, Japan, South Korea, China, Taiwan, Singapore, Israel, India, Australia and Brazil behaved while maintaining or changing their competitive status in nanotechnology. It was found that without simultaneous strategy of intensifying nanotechnology activity and the power of technological development, the achieved competitive status of the country in nanotechnology does not guarantee a place in the competitive group.
Keywords: competitive strategies of positioning of countries, nanotechnology.

Сажетак: На дуги рок нанотехнологија може начинити револуционарне помаке, који ће имати дубоке економске последице, па је предвиђање конкуренције и стратегија позиционирања земаља од великог значаја да би се могла проценити улога појединих земаља у нанотехнологији у будућности. Циљ овог рада јесте да се утврди како су се посматране земље – САД, Канада, Немачка, Велика Британија, Француска, Холандија, Шведска, Швајцарска, Италија, Русија, Јапан, Јужна Кореја, Кина, Тајван, Сингапур, Израел, Индија, Аустралија и Бразил, понашале у одржавању или промени конкурентског статуса у нанотехнологији. Утврђено је да без истовремене стратегије интензивирања нанотехнолошке активности и снаге технолошког развоја достигнути конкурентски статус земаља у нанотехнологији не гарантује останак у конкурентској групи.
Кључне речи: конкурентске стратегије позиционирања земаља, нанотехнологија.

Introduction

Nanotechnology[2] attracted wider attention in 2001, when the United States began the implementation of its national nanotechnology program by establishing the National

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Nanotechnology Initiative. Since then, nanotechnology has been found as a priority area of research in the national research programs of more than 60 countries worldwide (see: Roco, 2005; Roco, 2011; Sargent, 2012; Shapira & Wang, 2009). What "these programs have in common is a focus on developing nanotechnology R&D to increase their countries' industrial competitiveness in the global market" (Invernizzi, 2011, p. 2249).

Judging by the level of total investment in nanotechnology R&D, and by the growth rate of nanotechnology products markets, nanotechnology has gained a global character (see: Cientifica, 2011; Compano & Hullmann, 2002; Hulmann, 2006; Liu, 2009; Roco, Mirkin & Hersam, 2011). "Investment in nanotechnology research has risen from practically zero in 2000 to the round figure of $10 billion of public funding in 2011 (equal to €7.7 billion)". It is estimated that in 2011 (with PPP correction) China's €1.8 billion investment in nanotechnologies surpassed the U.S. investment of €1.44 billion. "The second biggest investor in 2011 was Russia with the public spending of €1.6 billion (PPP)" (ObservatoryNANO, 2011, p. 2). In addition to China, Russia and the U.S., countries that lead in public funding of nanotechnologies include Japan, Germany, France, the UK, South Korea, and Taiwan (with PPP correction) (Figure: Lux Research, 2011, p. 8). This indicates that nanotechnology represents an opportunity for all countries to reposition in this field and the global market in general. Corporate research and private funding were thought to have surpassed government funding figures as far back as 2004. The U.S. was the leader in corporate R&D investments. In addition to the U.S., countries that lead in corporate funding of nanotechnologies include Japan and Germany (Figure: Lux Research, 2011, p. 9). "The Woodrow Wilson Center Project on Emerging Nanotechnology reported 1.317 nanotechnology consumer products from 29 countries in 2010, compared to 54 products in 2005 when the inventory started" (Invernizzi, 2011, p. 2253).

A significant growth in nanotechnology is expected during the decade which will be mostly supported by partnerships between countries in the field of scientific research and the commercialization of nanotechnology innovations (see: Roco et al. 2011, Shapira &Wang, 2009; Tang & Shapira, 2011). In the long run, nanotechnology can make revolutionary breakthroughs that will have profound economic consequences. Therefore, the projection of competition and positioning strategies of countries is of great importance for the evaluation of the role of individual countries in nanotechnology in the future. According to Lux Research (2010a, 2011), the competitive status of a country in nanotechnology points to the achieved level of nanotechnology activity and the power of technological development. Guided by this, our hypothesis in this paper is: without simultaneous strategy of intensifying nanotechnology activity and the power of technological development the achieved competitive status of the country in nanotechnology does not guarantee a place in the

[2] „Nanoscience and nanotechnology are the study and application of extremely small things and can be used across all the other science fields, such as chemistry, biology, physics, materials science, and engineering" (US, NNI, website, in Јоксимовић, Цвијановић, Милановић и Ромчевић, 2014, стр. 201).

competitive group. The structure of the paper is as follows: Section 1 - Data and analyses, Section 2 – The results and the conclusion.

1. Data and analyses

We used research findings on a country's ranking in nanotechnology by Lux Research (2010a; 2011). Methodology by Lux Research is not publicly available (see: Lux Research, 2010b). The countries' ranking, according to these studies, reflects the final assessment of their level nanotechnology activity and the power of technological development on a scale from 1 to 5[3]. "The countries whose grade for the level of nanotechnological activity and the power of technological development is higher than 3 on a scale from 1 to 5 have the status of leaders. The countries whose grade is above 3 for nanotechnological activity and up to 3 for the power of technological development have the status of challengers. The countries whose grade is below level 3 for nanotechnological activity, and above 3 for the power of technological development have the status of nichers. And finally, the countries whose grades for the level of nanotechnological activity and the power of technological development are below 3 have the status of followers" (adapted from Lux Research, 2010a, by Hwang, in Milanović and Bučalina, 2013, p. 70; see also: Figure 1 in Milanović, Bučalina and Golubović, 2014, p. 57).

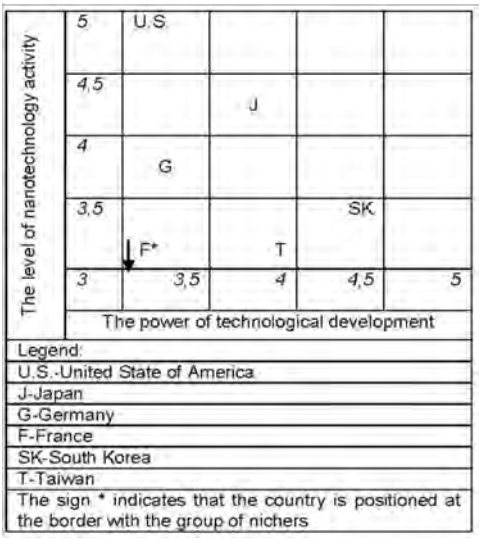
We chose the year of 2007 to be the first comparative year in presenting the competitive position of countries in nanotechnology by Lux Research. We chose the year of 2009 as a second comparative year (2009 is the final year to date in which the position of countries in nanotechnology is presented by Lux Research). The competitive status and position of the observed countries in nanotechnology in the period 2007-2009 are presented separately by competing groups in order to determine how the countries positioned within the group, or repositioned between the groups during this period (Figures 1-10; adapted from Lux Research, 2010a; 2011, p. 14).

1.1. The competitive status and the position of leader countries in nanotechnology

In 2007 the U.S., Germany, Japan, South Korea and Taiwan had the position of a leader (*Figure 1*).

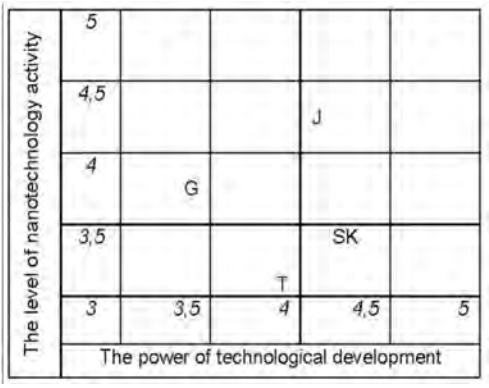
[3] The level of nanotechnology activity indicates the ability of a country to innovate in this field. The following observed and individually evaluated parameters have contributed in various percentages to the final assessment of level nanotechnology activity of each country: "nanotech initiatives (15%), nanotech centers (15%), government spending (10%), risk capital (10%), corporate R&D (10%), nanotech publications (15%), issued patents (15%), active companies (10%)". The power of technological development shows the opportunity of a country to develop its economy based on nanotechnology. The following observed and individually evaluated parameters have contributed in various percentages to the final assessment of power of technological development of each country: "R&D spending as % of GDP (25%), high or medium-high tech manufacturing as % of GDP (20%), science and engineering tertiary degrees per capita (15%), technology and science workforce per $ bn GDP (20%), expatriation of educated (10%), infrastructure (10%)" (Lux Research, 2011, p. 13).

Figure 1: The competitive status and the position of leader countries in nanotechnology in 2007



In 2008 the number of competitor countries in the leader group was reduced, and it remained steady in 2009 (*Figure 2*).

Figure 2: The competitive status and the position of leader countries in nanotechnology in 2008 and 2009

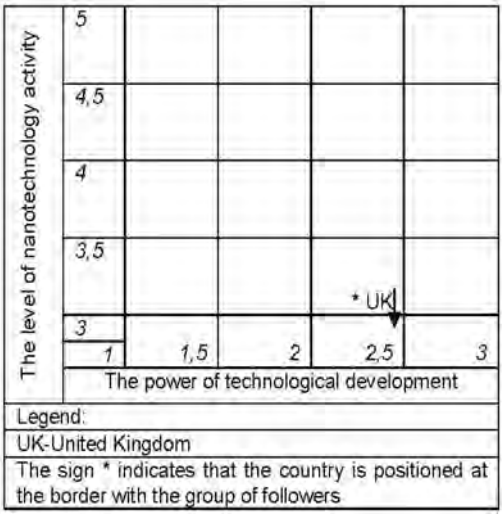


The reduction of the number of competitor countries in the leader group was caused by the U.S. and France, i.e. their repositioning into other competing groups.

1.2. The competitive status and the position of challenger countries in nanotechnology

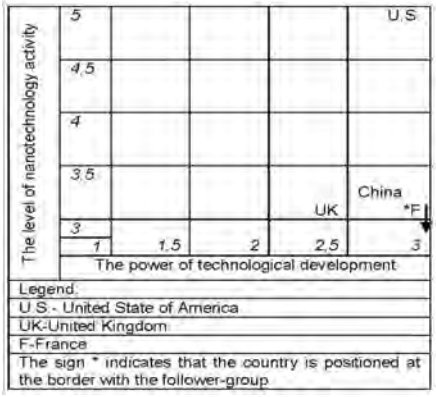
In 2007 the UK was the only competitor in the group, provided its grade according to which it was positioned at the border of a follower group is excluded (*Figure 3*).

Figure 3: The competitive status and the position of challenger-countries in nanotechnology in 2007



In 2008 and 2009 the UK, the U.S. and China had the competitive position of a challenger (*Figure 4*).

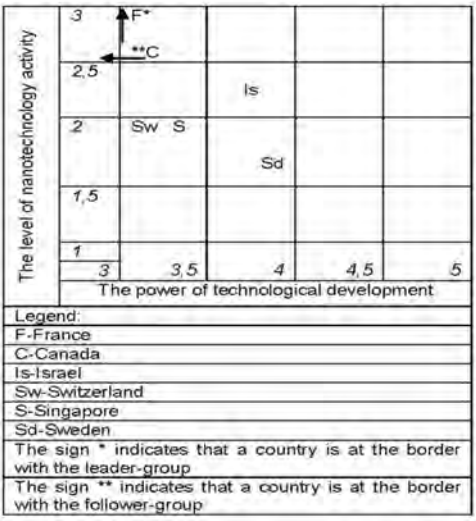
Figure 4: The competitive status and the position of challenger countries in nanotechnology in 2008 and 2009



1.3. The competitive status and the position of nicher countries in nanotechnology

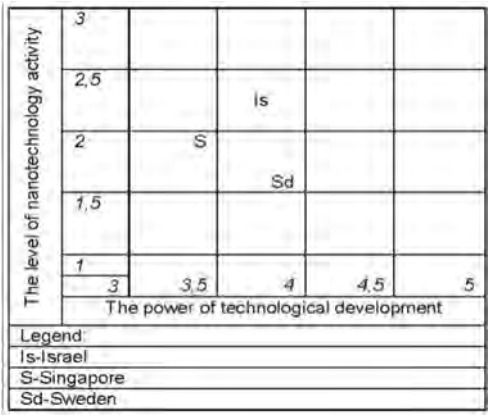
In 2007 Israel, Singapore, Switzerland and Sweden had the competitive position of a nicher (*Figure 5*).

Figure 5: The competitive status and the position of nicher countries in nanotechnology in 2007



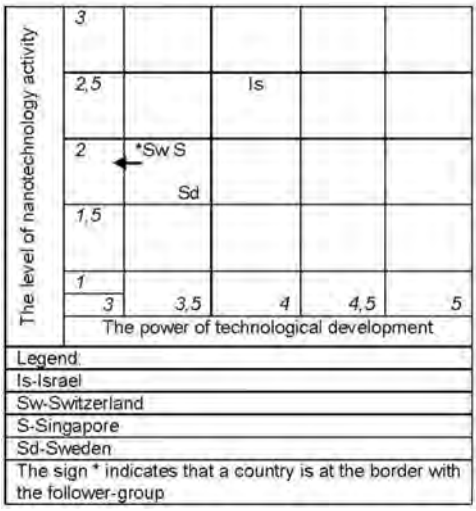
In 2008 Israel, Singapore and Sweden retained the position of the nicher (*Figure 6*).

Figure 6: The competitive status and the position of nicher countries in nanotechnology in 2008



In 2009 the number of countries in the nicher position increased compared to 2008. Switzerland contributed to that situation (*Figure 7*).

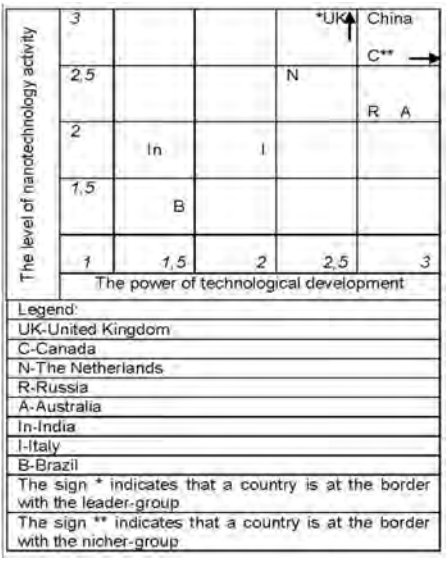
Figure 7: The competitive status and the position of nicher countries in nanotechnology in 2009



1.4. The competitive status and the position of follower countries in nanotechnology

In 2007 China, the Netherlands, Russia, Italy, Australia, India and Brasil had the competitive position of followers (*Figure 8*).

Figure 8: The competitive status and the position of follower countries in nanotechnology in 2007

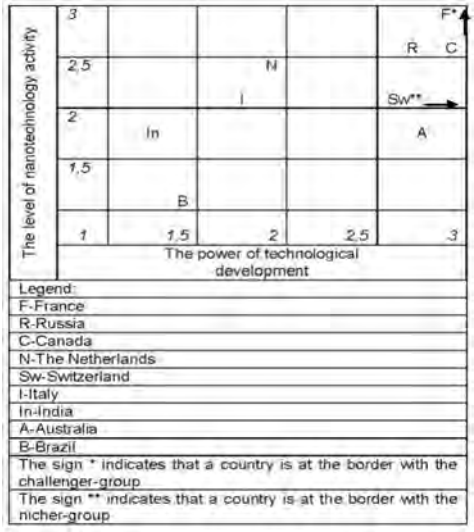


In 2008 the number of competitor countries in the group remained the same (*Figure 9*).

Figure 9: The competitive status and the position of follower countries in nanotechnology in 2008

In 2009 the number of competitor countries in the group was the same as in 2008 (*Figure 10*).

Figure 10: The competitive status and the position of follower countries in nanotechnology in 2009



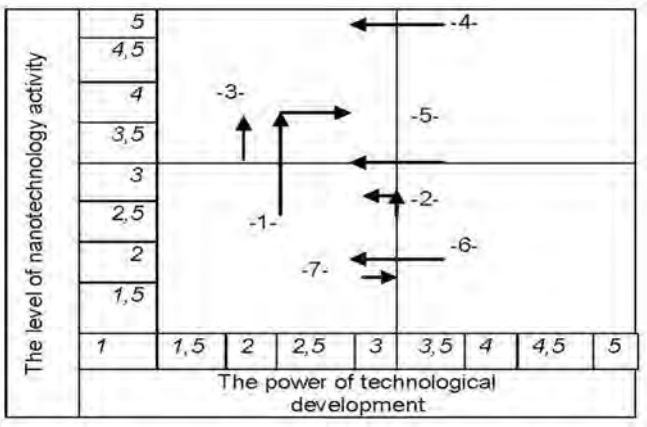
2. The results and the conclusion

We defined two groups of strategies based on the demonstrated behavior of countries: the strategies of intergroup competitive positioning and the strategies of intragroup competitive positioning.

Intergroup competitive positioning strategies are implemented by the countries in repositioning to another competitive group. They consist of (*Figure 11*):

- the 'up and to the right' strategy (the experience of China-position 1, Fig. 8-Fig. 4)
- the 'up and to the left' strategy (the experience of Canada-position 2, Fig. 8-Fig. 10)
- the 'up and in place' strategy (the UK-experience position 3, Fig. 8-Fig. 4)
- the 'in place and to the left' strategy (the U.S. experience - positions 4, Fig. 1-Fig. 4; the experience of France – position 5, Fig. 5-Fig. 4; the experience of Switzerland in 2008/2007 – position 6, Fig. 5-Fig.9)
- the 'in place and to the right' strategy (Swiss experience 2009/2008 – position 7, Fig. 9-Fig. 10).

Figure 11: Strategies of intergroup competitive Positioning



Intragroup competitive positioning strategies are implemented by the countries in maintaining or changing the position within the group. We have defined nine intragroup competitive positioning strategies (*Figure 12*).

The 'up and to the right' strategy means the simultaneous growth of nanotechnology activity and the power of technological development (the experience of Taiwan until 2007). The 'up and to the left' strategy implies the growth of

nanotechnology activity and the decrease of the power of technological development (the experience of Italy 2009/2008). The 'up and in place' strategy means the increase in nanotechnology activity and maintaining the same power of technological development (the UK experience 2008/2007, Russia 2009/2008 and 2008/2007, Israel 2009/2008).

The 'down and in place' strategy involves the decrease in nanotechnology activity and maintenance of power of technological development (the experience of Australia 2009/2008 and Brazil 2008/2007). The 'down and to the left' strategy involves a simultaneous decrease of both nanotechnology activity and the power of technological development (the experience Australia 2008/2007). The 'down and to the right' strategy means reducing the level of nanotechnology activity and increasing the power of technological development (unrecorded experience of any country).

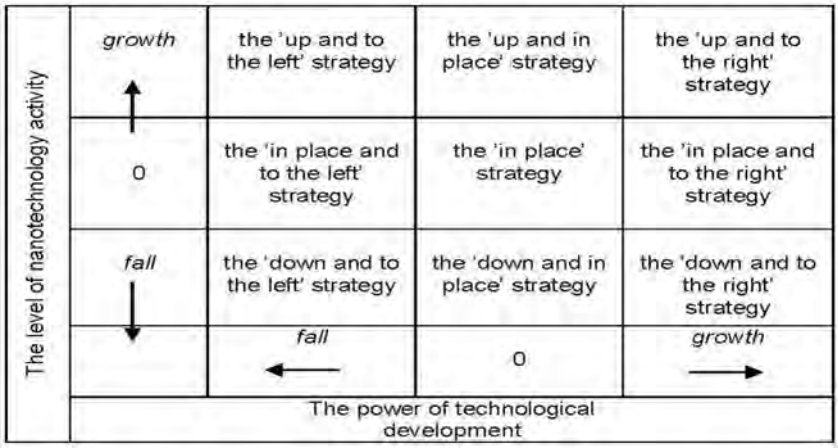
The 'in place and to the right' strategy means maintaining the nanotechnology activity and increasing the power of technological development (the experiences of Japan, Germany and Singapore 2008/2007). The 'in place and to the left' strategy means maintaining the level of nanotechnology activity and the decreasing the power of technological development (experiences of Japan and Sweden 2009/2008, Switzerland and France 2008/2007, South Korea 2009/2008 and 2008/2007).

The 'in place' strategy means maintaining the nanotechnology activity and the power of technological development (the experience of Germany, Taiwan, China, the UK, Canada, France, The Netherlands, India, Brazil, Singapore 2009/2008).

Finally, the presented changes in the competitive position (status) of the countries have served to verify strategies of positioning.

The results prove the hypothesis: without simultaneous strategy of intensifying nanotechnology activity and the power of technological development, the achieved competitive status of the country in nanotechnology does not guarantee a place in the competitive group (the experience of the U.S., the repositioning of the U.S. into the challenger-group – the deterioration of the position; the experience of China and Taiwan – the improvement of the position with the 'up and to the right' strategy of intergroup competitive positioning). Therefore, without simultaneous strategy of intensifying nanotechnology activity and the power of technological development there is no offensive intergroup competitive positioning towards a higher status group. Finally, without simultaneous strategy of increase in nanotechnology activity and maintaining the same power of technological development there is no higher status in the group (the experience of Russia – the improvement of the position in the follower group with the 'up and in place' strategy of intragroup competitive positioning).

Figure 12: Strategies of intragroup competitive positioning



The results of this paper are expected to be useful primarily to the countries – potential competitors in nanotechnology, including the Republic of Serbia and other less developed countries. That would provide them with an insight into positioning strategies of the countries that participate actively in this field.

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Résumé

In the long run, nanotechnology can make revolutionary breakthroughs that will have profound economic consequences. Therefore, the projection of competition and positioning strategies of countries is of great importance for the evaluation of the role of individual countries in nanotechnology in the future. The aim of this paper is to determine how the observed countries - The U.S., Canada, Germany, the UK, France, the Netherlands, Sweden, Switzerland, Italy, Russia, Japan, South Korea, China, Taiwan, Singapore, Israel, India, Australia and Brazil behaved while maintaining or changing their competitive position in nanotechnology. We used research finding on the countries' ranking in nanotechnology by Lux Research. According to Lux Research (2010a, 2011), the competitive position (status) of a country in nanotechnology points to the achieved level of nanotechnology activity and the power of technological development. Guided by this, our hypothesis in this paper is: without simultaneous strategy of intensifying nanotechnology activity and the power of technological development, the achieved competitive status of the country in nanotechnology does not guarantee a place in the competitive group. We detected the changes in competitive status of each country by analyzing their position in defined groups in the period 2007-2009. The presented changes in the competitive position of the countries have served to verify strategies of positioning. It was found that the results prove the hypothesis.

The results of this paper are expected to be useful primarily to the countries – potential competitors in nanotechnology, including the Republic of Serbia and other less developed countries. That would provide them with an insight into positioning strategies of the countries that participate actively in this field, so they could follow their experience and develop their own, nationally distinctive strategies of nanotechnology development and competitive positioning in the field of nanotechnology.