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Research and Development Expenditures of Innovative Enterprises in the Time of Crisis

Abstract

The paper presents the reaction of companies that have been making the largest outlays on R&D in a global scale to the current economic crisis. The analysis paid special attention to what extent R&D investments had been affected in comparison with net sales and profits and how R&D investments were affected across industries and regions.

The analysed enterprises reduced their net sales and profits to a greater extent than outlays on research and development, which confirms an anti-cyclical character of R&D activity in leading innovative enterprises. It has to be noted that in an analysed sample some companies significantly decreased outlays on R&D, however, there were some that increased these outlays in spite of worsening economic performance.

Among investigated sectors the one that proved to be the most crisis-resistant was the pharmaceuticals & biotechnology sector - classified as high technology, whereas the most crisis-prone one was the automotive sector.

Nonetheless, the thesis that high tech industries are more crisis-resistant cannot be substantiated – outlays on research and development in the following sectors: computer production, office equipment, semiconductors, telecommunications equipment (technology hardware & equipment) - classified as high technology in 2009 were reduced in relation to year 2008.

In an analysed group of enterprises the smallest "resistance" to crisis was observed in American companies. The enterprises from the EU also reduced

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research and development expenditures but the pace of a fall in these expenditures was smaller than in the case of American companies.

1. Introduction

The reduction of research and development expenditures can be a corporate reaction to an economic crisis - in case of business entities it is referred to as a "cyclical" one. The anti-cyclical character of R&D activities, however, means that in the time of crisis enterprises increase investments in research and development, thanks to which they can improve their competitive position in the market, even during the time of economic slowdown.

The aim of this paper is to examine the impact of crisis (2008-2009) on R&D activity of leading innovative enterprises. The analysis pays special attention to what extent R&D investments were affected in comparison with net sales and profits and how R&D investments were affected across industries and regions.

The introduction to the analysis is the presentation of various research and development strategies undertaken by enterprises as a reaction to an economic crisis. Later on, the changes of R&D expenditure in leading innovative companies in the period between 2008-2009 have been examined [enterprise ranking based on European Commission (2010), *The 2010 EU Industrial R&D Investment Scoreboard*, Luxemburg]. The cited report presents a group of leading innovative enterprises i.e. those whose R&D budget in 2009 exceeded the annual level of 28 million Euros. The criterion was met by 1400 companies (400 from the EU, 1000 from outside the EU).

2. Corporate Research and Development Strategies in the Time of Economic Crisis

The assessment of the impact of economic crisis on the dynamism of corporate research and development investment has evoked a lot of controversy in the economic literature.

Research and development activity is treated similarly to other functional segments (activities) of enterprises which take part in the process of creating value, i.e. value chain (Rymarczyk 2004, pp. 90–91). Thus companies can

decrease R&D expenditures in order to reduce costs, which defines this activity as cyclical in the time of crisis. As M. Cincera, C. Cozza, A. Tuebke, P. Voigt claim: „Implementation of new ideas can be postponed by enterprises to the times of economic recovery" (Cincera, Cozza, Tuebke, Voigt 2010, p. 3).

The factor that notably limits research and development expenditure is a difficult access to external sources of financing in the conditions of financial crisis. Enterprises that suffer from a fall of demand for their products and lower profits simultaneously lose the ability to apply for credit to finance R&D activities. Moreover, the reluctance of banks to lend their financial surpluses to other financial institutions limits their lending. In the economic literature it is emphasized that R&D expenditure has a "cyclical" character in case of enterprises facing credit crunch (Aghion, Askenazy, Berman, Cette, Eymard 2008, p. 2).

S. Martin, P. Valbonesi (Galli, Pelkmans 2000, p. 191) draw attention to a high level of risk accompanying R&D activity, which results in "underinvestment" in research and development in market system. A company that invents a new technology tries to protect it as long as possible from being publicized and used by other producers in order to benefit from their innovativeness for a long time (Górniewicz, Siemiątkowski 2006, p. 120). The process of using the knowledge by followers who do not incur expenditure on R&D activity but take advantage of results of other enterprises is inevitable. The fact that the knowledge is used by imitators diminishes the profits of innovators. The conflict between the public character of knowledge and profits made by innovator-enterprise is defined as a problem of appropriation. The risk of appropriating innovator's profits undoubtedly discourages research and development activities. In the time of crisis projects like that are highly adventurous (as it was already stated all R&D activities are) and often are "suspended", which supports treating R&D expenditures as cyclical.

However, reducing R&D expenditures can in future imply losing a competitive fight with companies that in the time of crisis did not decide to decrease this type of investments (Cincera, Cozza, Tuebke, Voight 2010, p. 4).

Describing research and development activity as a key factor of competitive advantage is a starting point for further analysis of anti-cyclical character of research and development expenditures. Thanks to increased expenditures on R&D companies not only improve their competitive position in a short time but they also gain a long-term competitive ability.

The negative impact of crisis on a company profitability can force it to undertake some actions stimulating growth of productivity (Voight, Moncada-

Paterno-Castello 2009, p. 5). So-called models of research and development activities (referred to as endogenous models of economic growth) by means of production functions enable to analyse the impact of R&D activity on productivity[1]. The characteristics of these theories, contrary to traditional endogenous growth models, is the occurrence of R&D sector (as a separate sector of economy) as well as modelling of technologies. The research proves that company innovation, described as their ability to adapt new solutions is a very important determinant of productivity growth (Bogliacino, Pianta 2009, p. 3).

According to the J.Schumpeter's concept of "creative destruction" crisis brings new opportunities for an enterprise including reorganization and increase of advancement level of R&D activity (Burzyński 2010, p. 42). A disappearing profitability rate forces business entities to implement new techniques of production. Companies that will not implement a proper reorganization of research and development activity as a reaction to crisis can be susceptible to bankruptcy.

Strategic and long-term character of research and development investments results in their "resistance" to crisis. Financial constraints being the effect of crisis to a greater extent influence decisions concerning the launch of new research and development projects (crisis can result in the abandonment of new research and development ventures), whereas the projects in the course of realization are influenced to a lesser extent. The abandonment of already commenced projects, advanced in the course of implementation generates so-called "sunk" costs (Cincera, op. cit., p. 3).

It must be stressed that an enterprise reaction to crisis to a great extent depends on the specificity of a given sector/branch. Enterprises belonging to high-tech industries find themselves in a better economic position than enterprises from other sectors (Leadbeater, Meadway 2008, p. 12). A. Stephen observes that enterprises from high-tech industries are more resistant to a business cycle than those belonging to sectors defined as medium-low-tech industries, so the reaction of the first group of enterprises to crisis can be described as anti-cyclical (Stephan 2004).

A crucial factor that determines the change of research and development expenditures as a reaction to crisis is also the size of a company characterized by the level of employment or annual turnover. Large enterprises i.e. those who

[1] More on so-called R&D models see Nowak (2007, s. 283).

possess relatively big budgets for research and development projects are more resistant to crisis than small and medium-sized enterprises. A pro-cyclical character of R&D expenditures in SME's sector is described by M. Cincera, C. Cozza, A. Tuebke, P. Voigt (Cincera M., Cozza C, Tuebke A., Voigt P. p. 5).

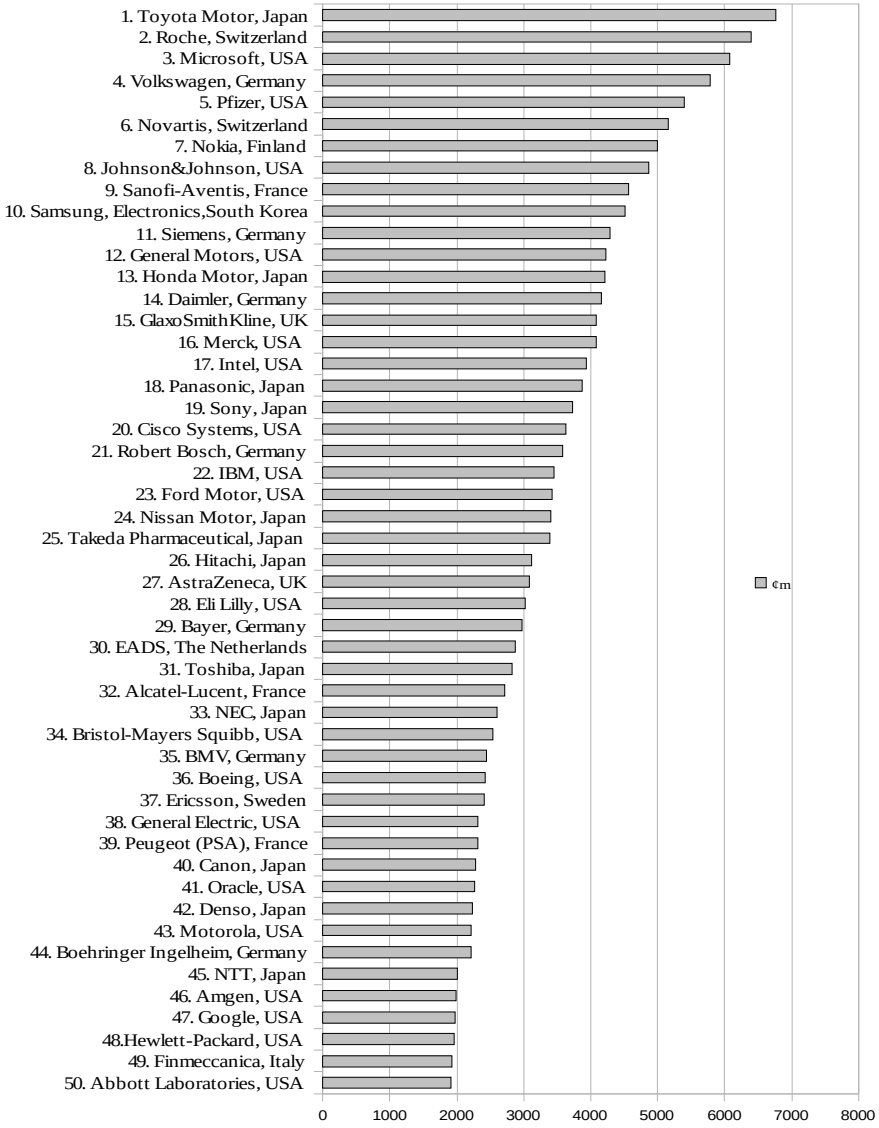
3. Changes in research and development expenditures of innovative enterprises as a reaction to crisis – overall analysis

1400 leading innovative enterprises allocated 402,2 bn Euros to research and development in 2009, which was only 1.9% less than in the previous year[2]. The crisis to a great extent reduced net sales (by 10.1 %) as well as profits (by 21%) of analysed companies, which may imply that investments in research and development are relatively resistant to recession. It is also confirmed by priority meaning of research and development activity for enterprises that incur the biggest expenditures on R&D on a global scale.

The global leader of R&D expenditures is still a Japanese company, Toyota (compare graph 1) although in 2009 the company reduced R&D expenditures in relation to year 2008 by 5.7% (compare Tab.1). Toyota kept its number 1 position in the ranking in spite of a significant decrease of net sales value and operating profit (European Commission 2010, p. 23).

[2] Analysis of research and development activity of innovative enterprises on the basis of the European Commission (The 2010), *EU Industrial R&D Investment Scoreboard*, Luxemburg. Group of 1400 leading innovative enterprises (400 from the EU, 1400 from outside the EU) consists of enterprises whose budgets for R&D exceed annually 28 m Euros.

Figure 1. Ranking of the world's top 50 R&D companies by their total R&D investment



Source: European Commission (2010).

Table 1. Characterization of the world's top 50 R&D companies (2009)

Compan	R&D Investment (change 09/08, %)	R&D/Net Sales ratio (2009, %)	Operating Profit (% of Net Sales, 2009)
1. Toyota Motor	-5,7	4,4	-3,2
2. Roche	9,4	19,4	25
3. Microsoft	-3,3	13,9	38,6
4. Volkswagen	-2,3	5,7	2,4
5. Pfizer	-2,4	15,5	21,3
6. Novartis	2,5	16,7	23,2
7. Nokia	-6,1	12,2	2,8
8. Johnson&Johnson	7,8	11,3	26
9.Sanofi-Aventis	0,3	15,3	24,6
10. Samsung Electronics	8	5,4	9,3
11. Siemens	1,9	5,6	4,9
12. General Motors	-24,1	5,3	-7,7
13. Honda Motor	-4,2	5,6	1,4
14. Daimler	-6,2	5,3	-0,3
15. GlaxoSmithKline	9,5	12,8	26,8
16. Merck	21,6	21,3	56,6
17. Intel	-1,2	16,1	15,6
18. Panasonic	-6,6	6,7	-5
19. Sony	-4,5	6,5	-3
20. Cisco Systems	1,1	14,4	19,9
21. Robert Bosch	-8,6	9,4	-3
22. IBM	-9,9	5,2	19,1
23. Ford Motor	-32,9	4,1	2,6
24. Nissan Motor	-0,4	5,4	-3,1
25.Takeda Pharmaceutical	64,3	29,5	20,3

26. Hitachi	-2,7	4,2	-1,8
27. AstraZeneca	-12	13,5	34,6
28, Eli Lilly	12,6	19,8	25,3
29. Bayer	8,8	9,5	9
30 EADS	4,4	6,7	-1,1
31. Toshiba	-3,8	5,7	-5
32. Alcatel-Lucent	-14,3	17,9	-5,8
33. NEC	-1,6	8,2	-6,3
34. Bristol-Mayers	1,7	16,9	29,8
35.BMV	-14,5	5,1	0,5
36. Boeing	0,9	5,1	3,1
37. Ericsson	-12,1	11,9	2,4
38. General Electric	10,1	2,1	18
39. Peugeot	-2,4	4,8	-2,8
40. Canon	-18,6	9,5	7
41. Oracle	17,6	12,1	33,6
42. Denso	-4,6	9,5	-2,5
43. Motorola	-22,5	14,4	-0,2
44. Boehringer Ingelheim	5	17,4	17,7
45. NTT	-1,1	2,6	10,9
46. Amgen	-5,5	19,6	37,6
47. Google	1,8	12	35,2
48. Hewlett-Packard	-20,4	2,5	8,8
49. Finmeccanica	9,9	11,7	7
50.Abbott Laboratories	2	8,9	24,7

Source: European Commission (2010).

Research and development activity remains strongly concentrated in enterprises that earmark a lot of money for R&D expenditures (10 leading innovative enterprises accounted for 13.6% of total expenditures on R&D among 1400 analysed companies).

In the group of 50 companies with the biggest R&D expenditures 30 enterprises reduced their investment in this activity (among which 15 companies by more than 5%). In the following companies a double-digit reduction of R&D expenditures was noted: Ford Motor (by 32.9%), General Motor (24.1%), Motorola (2.5%), Hewlett-Packard (20.4%), Canon (18.6%), BMW (14.5%), Alcatel-Lucent (14.3%), Ericsson (12.1) and AstraZeneca (12%). Among remaining 20 companies that noted the rise of R&D expenditures 9 enterprises increased this investment by more than 5%. Double-digit rise of research and development expenditures was observed in the following companies: Takeda Pharmaceuticals (64.3%), Merck (21.6%), Oracle (17.6%), Eli Lilly (12.6) and General Electric (10.1%).

In the whole group of enterprises increasing R&D expenditures we can find not only companies achieving good financial results (i.e. net sales or operating profit value) such as Huawei Technologies (increase of R&D expenditures by 27.8%), Apple (25.4%), Oracle (17.6%), but also companies experiencing a significant decrease of sales and profits: Bayer (8.8%,) General Electric (10.1%) or Daiichi Sankyo (12.9%). In the case of the latter company the decrease of profits in 2010 in relation to year 2009 amounted to 294% [European Commission (2010)].

4. Reaction of innovative companies to crisis – sectoral aspects

Research and development expenditures in the group of analysed enterprises are characterised by strong concentration in the cross section of economic sectors. Three among sectors of so-called ICB - Industry Classification Benchmark: Pharmaceuticals & Biotechnology, Technology Hardware & Equipment, Automobiles&Parts in 2009 accounted for 51.7% of total investments in R&D among 1400 innovative enterprises, whereas 15 leading innovative sectors accounted for 92% of total investments in R&D. In this paper the notion: innovative sectors is used to describe the sectors in which we find enterprises with the biggest share of total R&D expenditures of 1400 analysed enterprises.

Among 50 companies with particularly high R&D expenditures in 2009 35 enterprises belonged to three sectors: Pharmaceuticals & Biotechnology, Automobiles & Parts and Technology Hardware & Equipment (compare tab. 2), which confirms a strong concentration of research and development expenditures in cross-section of economic sectors.

Table 2. Leading innovative enterprises (50) by economic sectors

Sector	Total
Pharmaceuticals&Biotechnology	14
Automobiles&parts	11
Technology Hardware&Equipment	10
Software&Computer Services	4
Aerospace&defence	4
Leisure goods	3
Electronic&Electrical Equipment	2
Chemicals	1
Industrial Engineering	1

Source: European Commission (2010).

The best results in the field of R&D expenditures were achieved by Pharmaceuticals & Biotechnology sector and it was placed in No 1 position in the ranking of the most innovative sectors. R&D expenditures in this sector accounted for 19% of R&D investments observed in 1400 leading innovative enterprises. Research and development expenditures in Pharmaceuticals & Biotechnology sector in the group of analysed enterprises rose in relation to the previous year by 5.3% (compare tab. 3). Simultaneously, it is one of very few sectors that managed to increase net sales in the time of crisis (by 6.4% in relation to year 2008)[3]. To a great extent the strengthening of research and development ability was achieved by processes of economic concentration[4]. Pharmaceuticals&Biotechnology sector is also the sector characterised by the biggest intensity of research and development expenditures in 2009 (i.e. the relation of research and development expenditures to net sales).

No 2 position in the ranking of the most innovative sectors was occupied by Technology Hardware&Equipment sector which in 2009 accounted for 17.2% of total investments in R&D of 1400 innovative enterprises. However, this sector turned out to be little resistant to crisis – research and development expenditures of this sector in the group of analysed enterprises fell in relation to the previous year by 6.4%.

[3] European Commission (2010).

[4] p. Roche acquired Genentch, Pfizer acquired Wyeth, Sanofi-Aventis acquired Zentiva [IMMA (2009), *Mergers and Acquisitions Report*].

Automobiles & Parts sector proved to be even less resistant to crisis. Even though it is still one of the most innovative sectors (in the ranking of leading innovative sectors it held no 3 position in 2009 and accounted for 15.6% of total investments in R&D in analysed enterprises), it was this very sector in which the biggest decrease in R&D expenditures (by 11.6%) was observed.

Automotive industry that belongs to medium-tech industries was one of the first to suffer from an economic crisis in the area of sales, company value and profit. Among 12 global car manufacturers it was only Hyundai Motors that increased research and development expenditures by 2% in 2009.

Table 3. Changes of expenditures in innovative enterprises and the value of R&D intensity index by economic sectors

Sector	**R&D Investment (change 09/08, %)**	**R&D intensity, %**
1. Pharmaceuticals&Biotechnology	5,3	15,9
2. Technology Hardware&Equipment	-6,4	6,6
3. Automobiles&parts	-11,6	4,7
4. Software&Computer Services	-0,1	9,9
5.Electronic&Electrical Equipment	1,1	4,4
6. Chemicals	2,7	3,4
7. Aerospace&defence	-1	3,9
8. Leisure goods	-4,8	6,5
9. Automobiles&parts	-1,8	3,1
10. Industrial Engineering	-1,8	2,6
11. Fixed line telecommunications	1,3	1,7
12. Health care equipment&services	5,1	6,2
13. Oil&gas production	2,6	0,4
14. Food producers	0,8	1,2
All sectors	-1,9	3,5

Source: European Commission (2010).

Some sectors noted an increase of research and development expenditures in spite of a significant fall of net sales (Chemicals, Oil & Gas Production). Research and development expenditures in Chemicals sector in the group of 1400 analysed enterprises increased in relation to the previous year by 2.7% and

Oil & Gas Production by 2.6 % (net sales value fell respectively by 26% and 16.1%). The increase of R&D expenditures in Health care equipment & services sector is also an example of a positive, anti-cyclical reaction to crisis.

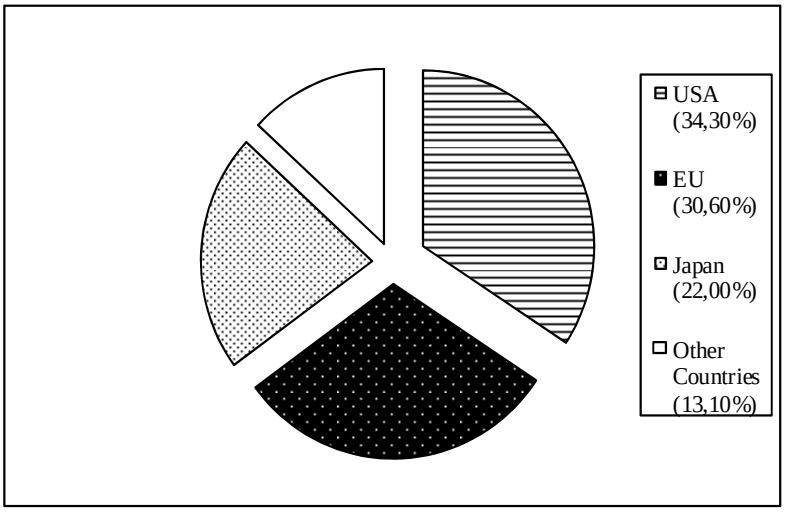
4. Reaction of innovative companies to crisis – geographical aspects

The factor differentiating the changes in research and development strategies of innovative companies in their response to crisis is their geographical location.

1400 enterprises analysed in the cited report which were classified on the basis of their research and development expenditures can be divided on the ground of their geographical location into two group: 400 leading enterprises from the EU, 504 from the USA (27 less than the previous year ranking), 259 from Japan (3 more than in the 2008 ranking) and 237 business entities from other countries (24 more than in the previous year).

In 2009 American enterprises accounted for 34.3% of total investments in R&D among 1400 innovative enterprises, whereas enterprises from the EU for 30.6% (compare graph 2).

Figure 2. Research and development expenditures of leading innovative enterprises by the most important regions of the world in 2009



Source: European Commission (2010).

The share of American companies in total R&D expenditures of 1400 leading innovative enterprises decreased significantly – from 37.7% in 2008 to 34.3%, whereas the share of the EU enterprises increased by 1.7 percentage points. Japanese companies maintained their share in research and development investments in the analysed companies on the same level. However, the enterprises from other parts of the world increased their share in total research and development expenditures of 1400 leading innovative enterprises by 1.9 percentage points.

The companies that turned out to be the least resistant to crisis were the companies from the USA which reduced R&D expenditures by 5.1% in relation to the previous year. The enterprises from the EU that reported a fall in sales similar to American companies but a bigger fall in profits reduced R&D investments by 2.6%. Japanese companies in spite of a significant fall in net sales (by 10%) and a dramatic fall in profits (by 88.2%) managed to maintain research and development expenditures on the same level. However, the companies from other parts of the world increased research and development expenditures by 5.8% despite a fall in sales by 4.8% and a fall in profits by 12.4%.

The companies whose research and development activity proved to be exceptionally resistant to crisis were the enterprises from other Asian countries – innovative companies from this region increased research and development expenditures by 11% and at the same time their net sales rose by 5%. The highest dynamism of research and development expenditures was observed in enterprises from China (40%), India (27.3%), Hong Kong (14.8%), South Korea (9.1%) and Taiwan (3.1%).

Pro-cyclical reaction of Asian enterprises to crisis is also confirmed by the fact that new companies from this region appeared in the ranking of the most innovative companies in the world. As it was already mentioned the ranking from 2009 included also three Japanese companies, six companies from China, four from Taiwan, four from South Korea, two from Hong Kong and two from Singapore.

The crisis has not changed sectoral specialisation of the regions. Enterprises from the USA dominate in sectors producing high-tech goods, whereas companies from the EU in sectors producing medium-low tech goods. 69% of research and development expenditures in American companies in 2009 went to high-tech sectors, and 25% to medium-low-tech sectors. However, "only" 35% of research and development expenditures in the European innovative companies went to high-tech sectors and 48% to medium-high technology sectors.

5. Conclusions

In the economic literature we can find arguments in favour of cyclical as well as anti-cyclical enterprises' reactions to economic crisis.

In the analysed period 1400 leading innovative enterprises reduced to a greater extent net sales and profits than research and development expenditures, which supports an anti-cyclical reaction of innovative companies to crisis. Some companies increased research and development expenditures in spite of worse economic results. However, some analysed companies reduced research and development expenditures, which confirms differentiating a research and development strategy as a reaction to crisis.

The impact of crisis on corporate research and development activity depends on an economy sector. Among analysed companies the most resistant to crisis were the enterprises belonging to Pharmaceuticals & Biotechnology (high-tech sector) and the most susceptible were the enterprises from Automobiles & Parts sector (medium technology). On the other hand reduction in research and development expenditures was noted also in Technology Hardware & Equipment sector that belongs to high technologies. However, the hypothesis that high–tech industries are more resistant to crisis is not supported -in a group of sectors that showed a cyclical reaction to crisis we find both high-tech and medium-tech sectors.

The reaction of innovative companies to crisis was determined also by their geographical location. American companies as well as those from the EU in response to crisis reduced research and development expenditures, whereas Japanese companies maintained them on the unchanged level. Research and development activity in companies from the other geographical regions was definitely anti-cyclical (particularly the Asian companies).

It must be noted, however, that analysed enterprises represent a sector of big enterprises which possess a large budget for research and development, thus their reaction to crisis is different than the reaction of less innovative companies.

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Streszczenie

NAKŁADY NA BADANIA I ROZWÓJ PRZEDSIĘBIORSTW INNOWACYJNYCH W DOBIE KRYZYSU

W opracowaniu zbadano reakcję firm charakteryzujących się największymi nakładami na B+R w skali świata na aktualny kryzys. Celem analizy była odpowiedź na pytanie, jak wrażliwa na kryzys okazała się zmiana nakładów na badania i rozwój przedsiębiorstw innowacyjnych w porównaniu ze zmianami sprzedaży i zysków oraz, w jaki sposób charakter sektora i pochodzenie geograficzne przedsiębiorstw wpływa na zmiany ich nakładów badawczo-rozwojowych.

Analizowane przedsiębiorstwa w większym stopniu ograniczyły sprzedaż netto oraz zyski, niż nakłady na badania i rozwój, co potwierdza względną odporność firm innowacyjnych na kryzys. Co prawda w badanej próbie część przedsiębiorstw znacząco zmniejszyła nakłady na badania i rozwój, jednakże niektóre firmy zanotowały wzrost nakładów na B+R, mimo pogorszenia wyników ekonomicznych.

Wśród badanych sektorów najbardziej odpornym na kryzys okazał się, zaliczany do wysokich technologii, sektor Pharmaceuticals&Biotechnology, natomiast szczególnie podatnym na kryzys sektor Automobiles&parts. Nie znajduje jednak potwierdzenia teza, że przemysły wysokiej techniki są bardziej odporne na kryzys – wydatki na badania i rozwój sektora: Technology Hardware&Equipment (zaliczanego do wysokiej techniki) w 2009 r. zmniejszyły się w stosunku do 2008 r.

W badanej zbiorowości przedsiębiorstw najmniejszą „odporność" na kryzys wykazały firmy amerykańskie. Firmy wywodzące się z UE również zanotowały zmniejszenie nakładów na badania i rozwój, jednak tempo spadku nakładów badawczo-rozwojowych było tu mniejsze niż w przypadku firm amerykańskich.