

EVOLUTION OF RESEARCH AND DEVELOPMENT EXPENDITURE AT GLOBAL, REGIONAL AND NATIONAL LEVELS

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ABSTRACT. Currently, the funding system of the research sector around the world has undergone impressive structural changes. The purpose of this study is to present the evolution of research and development expenditures: total, regionally, by leading countries and in the Republic of Moldova. The analysis of global expenditures for research and development, over a period of 15 years, highlighted their doubling.

KEYWORDS: *research sector, research and development funding, public investment in science*

INTRODUCTION

Public investments in research and development contribute to the achievement of strategic objectives for sustainable development, but also to the evolution of the national research system. The activities performed by the research sector include activities, which generate the creation of new products and services, as well as the scientific solution of national and international problems. Budgetary expenditures for research and development represent the state's financial effort for development strategic priorities. The research sector involves high costs because it needs special material resources and highly qualified personnel trained in scientific activity.

The research objectives are: analysis of global expenditures for total research and development and in regional division; analysis of global research and development expenditures by leading countries; analysis of research and development expenditures in the Republic of Moldova.

The analysis of public expenditures for research and development is a subject covered over the years by scientists and researchers, among which we can note some local authors such as: V. Fetiniuc, I. Luchian [2], T. Furdui [3], Gh. Cuciureanu, C. Ungur [1], A. Şuşu-Ţurcan, O. Oprea [6], and others. Their works and studies are a real treasure for science.

The general research methods used in this study are oriented mainly at presenting the dynamics and trend of total global expenditures in the regional division, in the leading countries and in the Republic of Moldova. The study period is 15 years, from 2005 to 2019. The following research methods were applied are: statistical method, to determine the indicators: annual growth rate, increase, average and quota of global research and development expenditures; the analytical-comparative method, for the analysis and comparison of the global expenditures for research and developed by regions and countries; the documentation method, for selecting the information necessary for the present study through periodic observations of the annual evolution of the researched indicators.

For the elaboration of this study, the following informative materials were used: Annual R&D Magazine reports for the years 2005-2019 [9], Annual reports on the activity of the Council for Science and Technological Development for the years 2005-2017 [5],

Allocation reports budget of the Ministry of Culture Education and Research for the years 2018-2019 [8] and others.

RESULTS AND DISCUSSIONS

Analysis of global expenditures for total research and development and in regional division

The total volume of global research and development expenditures, during the years 2005-2019, registered an increasing trend (figure no. 1).

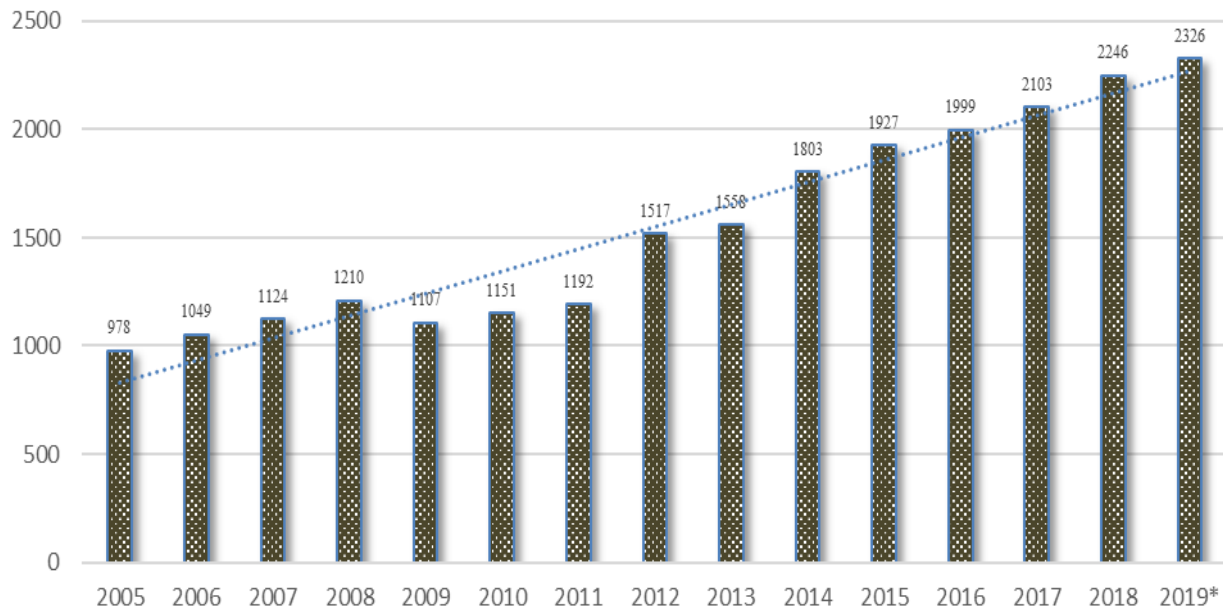


Figure no. 1. Dynamics of global research and development expenditures during the years 2005-2019, billion USD

** Note: for 2019 have been included planned expenses*

Source: elaborated by the author after [9]

Thus, the overall expenditures for research and development, in the analyzed period, increased by ≈ 2.4 times, or by 1347.9 billion USD, from 978.3 billion USD in 2005, up to 2326.2 billion USD in 2019. In 2019, an increase in global research and development expenditures was forecast by ≈ 79.7 billion (or $\approx 3.5\%$) compared to 2018. The average annual growth rate of global research and development expenditures in the period studied was 106.2%, and the highest annual growth rate is recorded in 2012 compared to 2011 (127.3%), where research and development expenditures increased from 1192 billion USD in 2011 to 1517 billion USD in 2012. From 2015 to 2019, the annual increase in global research and development expenditures ranges from 3.5 % and 6.8%. In 2009, due to the global economic crisis, there was a decrease, compared to 2008, of global expenditures on research and development by ≈ 103.2 billion USD or 8.5%. At the same time, it is noteworthy that, during the analyzed period, the annual growth rate increased ≈ 1.04 times. Currently, there is a slight upward trend in overall research and development expenditures.

The dynamics of global expenditures for research and development in the regional division is presented in table no. 1.

Table no.1. Dynamics of global research and development expenditures for the period 2005-2019 in regional division, billion USD

Region / year	America	Asia	Europe	Rest of world
2005	369,1	341,3	236,1	31,8
2006	374,9	387,2	264,3	23
2007	387	436,2	276,3	24,4
2008	401,1	494,4	288,8	25,9
2009	433,2	372,5	267	34,3
2010	446,7	400,4	268,6	34,8
2011	458	421,1	276,6	36,3
2012	485	601	350	81
2013	489	637	349	83
2014	577	724,8	387,7	113,6
2015	590,4	795,2	416,6	124,3
2016	616,3	878,8	435,3	68,4
2017	630,8	897,8	441,5	132,4
2018	664,9	977,2	462,8	141,5
2019*	681,6	1028,2	472,2	144,2

* *Note: for 2019 have been included planned expenses*

Source: elaborated by the author after [9]

During the studied period, the world leaders in funding of the research sector are: America, Asia and Europe. If in 2005, the world leader in this regard was America, then, starting with 2012, Asia becomes the leader. Asia's global research and development expenditures averages 626.2 billion USD annually and they grew up 686.9 billion USD, or ≈ 3 times, from 341.3 billion USD in 2005 to 1028.2 billion USD in 2019. Global research and development expenditures in Asia increased in 2019 compared to 2018 by 51 billion USD, or by $\approx 1.1\%$ (from 977.2 billion USD to 1028.2 billion USD). America's research and development expenditures averages 507 billion USD annually and has increased ≈ 1.8 times, or 312.5 billion USD, from 369.1 billion USD in 2005 to 681.6 billion USD in 2019. The dynamics of America's global expenditures on science is positive. The annual growth rate of America's global research and development expenditures in 2019 compared to 2018 is 102.5%, they increased by 16.7 billion USD (from 664.9 billion USD to 681.6 billion USD). Another positive trend has been the financing of science in Europe, where on average about 346.2 billion USD is invested in research and development, and the increase is ≈ 2 times, from 236.1 billion USD in 2005 to 472.2 billion USD in 2019.

At the same time, in 2013, the volume of global expenditures on research and development in Europe decreased, from 350 billion USD in 2012 to 349 billion USD in 2013. The increase in global expenditures on research and development in Europe increased in 2019 compared to 2018 by USD 9.4 billion USD (from 462.8 billion USD to 472.2 billion USD). Global research and development expenditures for the rest of the world averages 73.3 billion USD annually. The increase in the volume of global expenditures on research and development of other regions in the period under review is ≈ 4.5 times, or 112.4 billion USD. The annual growth rate of global research and development expenditures of the analyzed region, from 2019 to 2018, is 101.9%, increased by 2.7 billion USD (from 141.5 billion USD, to 144.2 billion USD). The highest average annual growth rate of global expenditures on research and development is observed in the "Rest of the World", about 116.8% annually.

Asia has an average annual growth rate of science funding of $\approx 108.4\%$, and America and Europe have an average of 105% annually.

From figure no. 2, the dynamics of the share of research and development expenditures in regional aspect, for the period 2005-2019 can be seen.

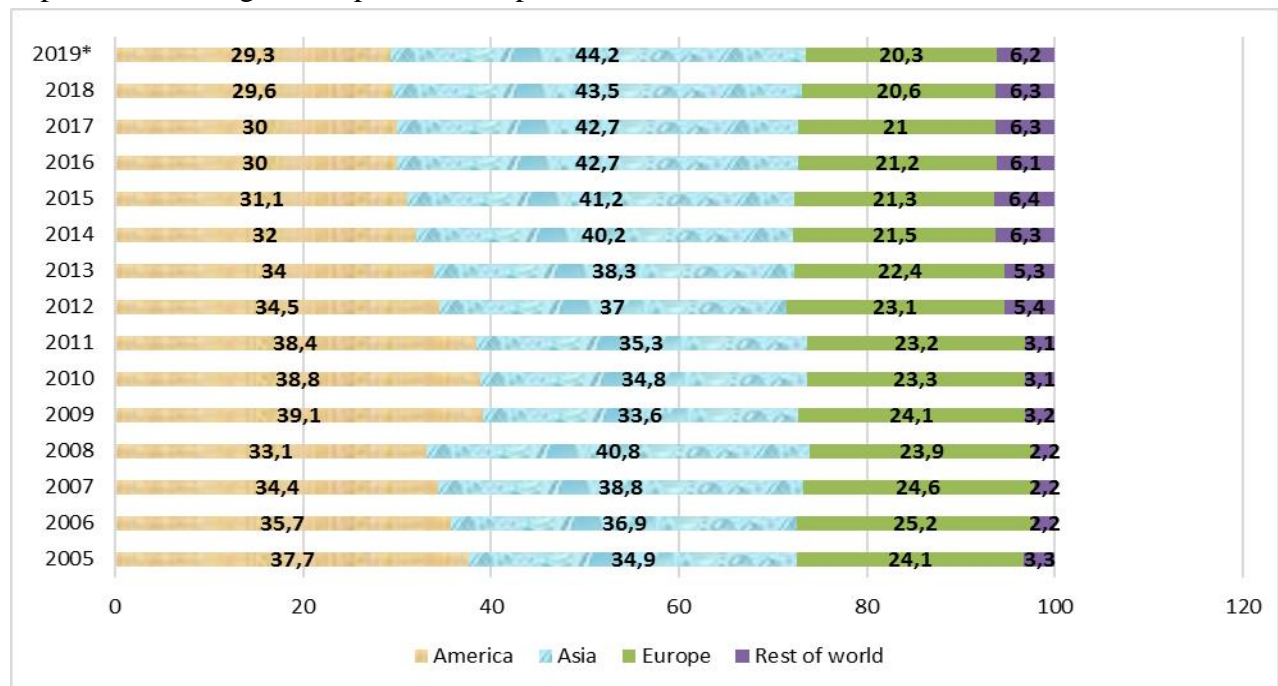


Figure no. 2. Dynamics of the share of research and development expenditures in regional aspect for the period 2005-2019 in regional division, in%

* Note: for 2019 have been included planned expenses

Source: elaborated by the author after [9]

During the study period, Asia has the largest quota of global research and development expenditures, averaging 39% , followed by America with an average of 34% and then Europe with an average quota of 23% of total global research and development expenditures. In 2019 compared to 2018, only Asia recorded an increase in the quota of total global expenditures on research and development in the regional division, the increase was $\approx 0.7\%$, but at the same time, America and Europe recorded a decrease in the quota in the regional division of research and development expenditures by $\approx 0.3\%$ each. The rest of the world registered a decrease in the quota in the regional division of research and development expenditures by $\approx 0.1\%$.

Analysis of global research and development expenditures by leading countries

In table no. 2, the dynamics of the global research and development expenditures of the leading countries are presented.

Table no. 2. Dynamics of global research and development expenditures for the period 2015-2019 divided by leading countries, billion USD

Country	2015	2016	2017	2018	2019*
US	496,8	521,8	537,6	565,8	581
China	372,8	424,8	444,8	485,5	519,2
Japan	164,6	185,9	185,5	191,5	193,2
Germany	112,2	114,6	114,8	120,8	123,2
India	66,5	73,6	76,9	86,2	94,1

* Note: for 2019 have been included planned expenses

Source: elaborated by the author after [9]

From 2015 to 2019, the top 5 countries that invest the most in research and development are: USA (≈ 540.6 billion USD annually), China (≈ 449.4 billion USD annually), Japan (≈ 184.1 billion USD annually), Germany (≈ 117.1 billion USD annually) and India (≈ 79.5 billion USD annually). The largest increase in global research and development expenditures in China is ≈ 1.4 times, or 146.4 billion USD, from 372.8 billion USD in 2015 to 519.2 billion USD in 2019. India's global research and development expenditures they grew up ≈ 1.4 times, or 27.6 billion USD, from 66.5 billion USD in 2015 to 94.1 billion USD in 2019, which favored the acceleration of India from 8th place in 2009, 6th place in 2015 and then 5th place in 2019. The United States of America has increased global expenditures on research and development in the last 5 years ≈ 1.2 times, or 84.2 billion USD, from 496.8 billion USD in 2015 to 581 billion USD in 2019. Japan also increased global expenditures for research and development on ≈ 1.2 times, or by 28.6 billion USD (from 164.6 billion USD in 2015, to 193.2 billion USD in 2019). Over the period under review, global expenditures on research and development in Germany they had slowest growing, by about 1.1 times, or by 11 billion USD, from 112.2 billion USD in 2015 to 123.2 billion USD in year 2019.

In the analyzed period, 3 out of 5 countries registered a positive increase in the annual growth rate of global research and development expenditures: India (101.6%), United States of America (100.3%) and Japan (100.2%).

Referring to research expenditures, an important aspect of funding is the quota of budget expenditures for research and development in GDP (figure no. 3).

Budgetary expenditures for research and development in GDP in the leading countries for investment in research and development, in 2019, constitute on average 2.3% and register an increasing trend compared to 2009 (on average $\approx 1.9\%$), with 0.4% or ≈ 1.2 times. Romania remains at the same level of 0.5% during the analyzed period. However, the Republic of Moldova has the lowest quota compared to other states of the European Union and neighboring, which is only 0.3% of GDP, down from 2009, by 0.2% (≈ 7 times).

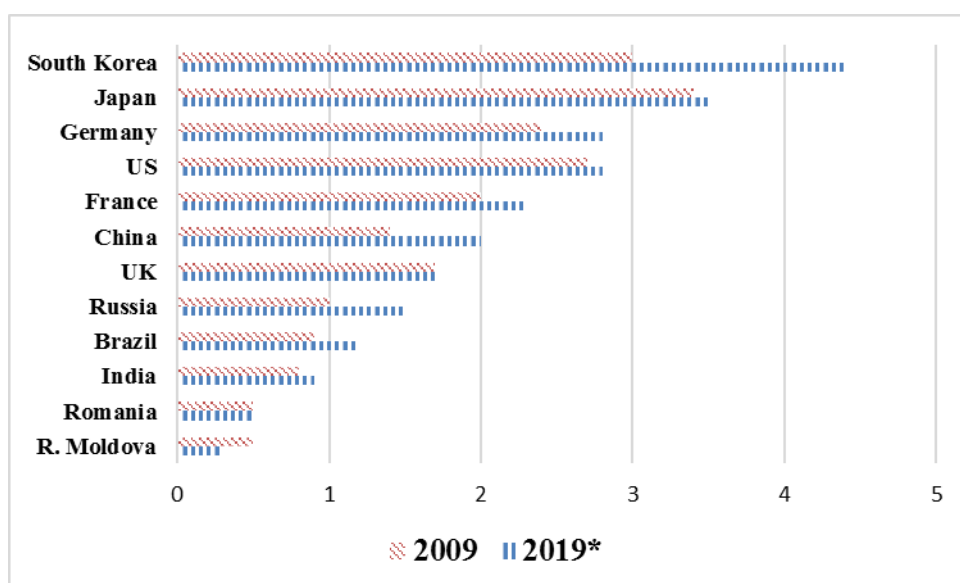


Figure no. 3. The percentage of budgetary expenditures for research-development-innovation in GDP, in some countries, 2009 and 2019, in %

* Note: for 2019 have been included planned expenses

Source: elaborated by the author after [7]

Analysis of research and development expenditures in the Republic of Moldova

According to the National Program in the fields of research and innovation for the years 2020-2023 [4], in the Republic of Moldova, the financing of the research sector is made on the following strategic priorities: Health; Sustainable agriculture and food security; Environment and climate change; Societal challenges; Economic competitiveness and innovative technologies, with an estimated financial effort as follows: for 2020, the amount of 227.7 million MDL is provided; for the year 2021 - 238.9 million MDL; for the year 2022 - 257.9 million MDL; and for the year 2023 in the volume of 276.3 million MDL. The annual increase is $\approx 5\%$, due to the annual decrease of costs for institutional consolidation measures in the fields of research and innovation, for the financing of which, it is estimated: in 2020 in the amount of 149.8 million MDL; in 2021 - 128.7 million MDL; in 2022 - 110.5 million MDL; and in 2023 - 92.1 million MDL.

In 2020, expenditures for research and development in the volume of 374.5 million MDL were planned from the state budget, which is ≈ 28 million MDL more than the amount planned in 2019 (346.5 million MDL).

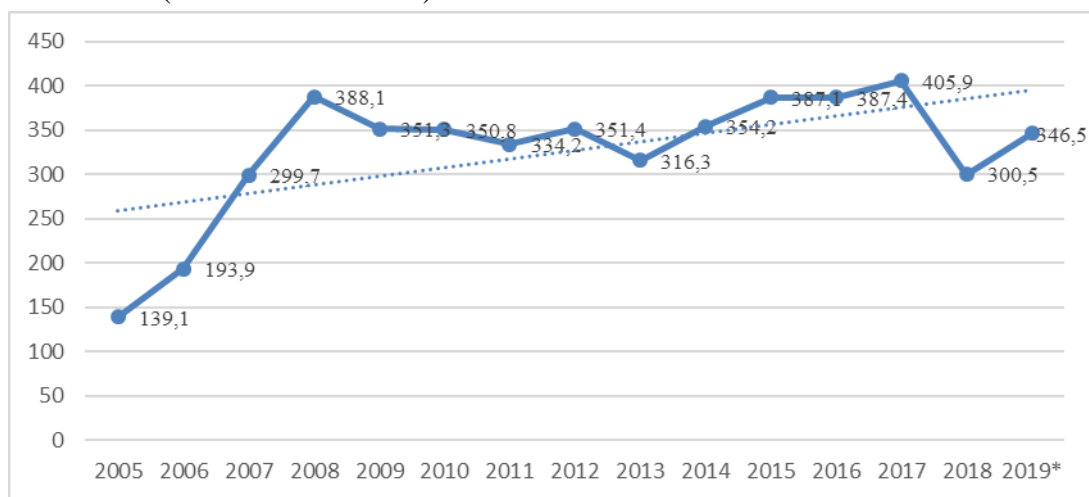


Figure no. 4. Dynamics of expenditures from general resources and revenues collected for research-development-innovation in the Republic of Moldova, years 2005-2019, million MDL

* **Note:** for 2019 have been included planned expenses

Source: elaborated by the author after [5, 8]

During 15 years, from 2005 to 2019, the budgetary expenditures for research-development-innovation increased ≈ 2.5 times or by 207.4 million MDL, from 139.1 million MDL in the year 2005, up to 346.5 million MDL in 2019 (figure no. 4).

The highest annual growth rate of budget allocations for the research sector in the Republic of Moldova is found in 2007 compared to 2006 $\approx 154.6\%$. And the lowest annual growth rate, which means a decrease, is found in 2018 compared to 2017 - about 74%, simultaneously with the change of the founder of research institutes.

For the period 2021-2023, the trend of the volume of budget allocations for financing scientific activities and maintaining the infrastructure of research institutions will be constant, and the budgetary costs for the research sector are estimated at ≈ 368 million MDL annually.

The value of Gross Domestic Product (GDP) has a direct influence on the funding of the research sector, because, since the approval of the Science and Innovation Code, the amount of annual budget allocations to the research sector is set as a percentage of GDP. In the Republic of Moldova, GDP tripled, or increased by 132.2 billion MDL, from 60 billion

MDL in 2009 to 178.9 billion MDL in 2017, averaging 118.8 billion MDL. The average annual GDP growth rate is 113.4%. During the study period, the share of research sector funding in % of GDP averaged 0.4% and decreased by ≈ 2.6 times or by 0.4% from 0.59% in 2009 to 0.23 in 2017. The average annual growth rate of the share of science funding in GDP is 90.5%. It is noteworthy that the annual growth rate of GDP is 13.4% higher, and the annual growth rate of the share of science funding relative to GDP is 9.5% lower than 100%. The population is the main resource for supplying human capital to the research sector and for carrying out scientific research services. The evolution of the number of the present population has a decreasing trend, being on average 3392.6 million people. During the years 2009-2018, the number of the present population decreased about 1.03 times or by 89.4 million people. This fact is due to the negative natural balance, which during this period decreased threefold, from 1.3 thousand in 2009 to 4.6 thousand in 2018. At the same time, they negatively influenced the migration processes that the Republic of Moldova goes through, where annually, an average of 3.2 thousand people leave the country to change their place of residence. The scientific human potential is a resource that contributes to the generation of new knowledge and the attraction of vital financial resources for the organization. The total number of employees in the research-development activity is decreasing and decreased by 973 employees in 2009 from 5315 employees, in 2018 to 4451 employees. The average number of employees in the analyzed period is about 5 thousand employees. The largest share in the total number of employees is occupied by researchers - 66.1%, which decreased by ≈ 1.2 times, or by 507 employees, from 3561 employees in 2009 to 3054 employees in 2018 [10]

CONCLUSIONS

Total global expenditures on research and development in the last 15 years have increased and doubled. If in 2005, the world leader in public funding of the research sector, in regional division was America, then, starting with 2012, Asia becomes the leader. Asia is performing well on public investment in research and development thanks to China, Korea and India, which have increased public expenditures on science.

Leading countries invest in research and development public resources on average over 2% of GDP and mark an increasing trend of theirs.

Budget expenditures for research-development-innovation in the Republic of Moldova have also doubled, but for the period 2021-2023, the trend of public investment to finance scientific research and to maintain the infrastructure of research organizations will be constant. The annual growth rate of GDP exceeds by 22.9% the annual growth rate of the share of science funding relative to GDP.

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