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How soon could Romania close the R&D gaps against EU-28?

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Abstract

Increasing EU’s Gross domestic expenditure on research and development (R&D) at 3% of the GDP is one of the five EU headline targets included in Europe 2020 strategy. Higher R&D investments in member states, as well as the design and implementation of adequate national research and development policies should not only reduce disparities with respect to R&D, but also foster economic growth and stimulate convergence. Romanian national strategies also acknowledge R&D as a priority sector, given its potential to increase labour productivity, competitiveness and economic growth, but up to now there is low convergence of the Romanian R&D system with the European one. In this context, our paper aims to assess the time required to close the gaps in research and development between Romania and the EU by means of catching-up computational methods. We analyze the likelihood of equalizing EU average using data on various indicators in the R&D field over 2005-2012. The necessary growth rate to achieve this goal is estimated under different scenarios: pessimistic, realistic and optimistic. We found that the time span required to fill the Romanian R&D system’s gaps against EU varies between 5 and 25 years, depending on the indicator considered. Unfortunately, there are also R&D indicators for which the gaps got larger over 2005-2012, therefore catching-up is unlikely on the short run. As regards the Summary Innovation Index, efforts to equalize EU-28 average would be considerable since Romania should increase its annual SII rhythm of growth by four times, even in the pessimistic scenario of 30 years time horizon.

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1. Introduction

Romanian national strategies acknowledge R&D as a priority sector that has a high potential to increase labour productivity, competitiveness and economic growth. In the current context marked by the persistent problems following the recent economic crisis “Economic recovery and long-term growth, technological performance of Romanian economy imposed by strong competition at European and global level depends on the answers offered by researchers to actual problems” (Sandu, 2010). Therefore it is crucial to provide adequate support for the R&D system, as well as to choose the appropriate tools for transposing the research results in products and services able to support economic development.

Fig. 1. Evolution of Summary innovation index, Romania against EU-28 average, 2006-2013
Source: processed by authors using Eurostat online tools available at http://ec.europa.eu/enterprise/policies/innovation/policy/innovation-scoreboard/2014/index_en.htm
Efforts had been made to provide sufficient resources for the R&D sector\(^1\), to increase its performance and to transfer rapidly the knowledge results into economy. Unfortunately, there are still huge gaps between Romania and EU in terms of R&D resources and performance and up to now there is little convergence of the Romanian R&D system with the European one (Figure 1).

Previous studies on the problems of the R&D field in Romania revealed the challenges related to the provision of financial inputs for research activities, especially in the context of economic crisis, the lack of incentive for support of R&D within private sector, the low absorptive capacity of EU funds through Framework Programs (Sandu et al., 2008; Sandu, 2010; RO INNO Romania, 2011; Ranga, 2010) and also the high potential of research-development and innovation in increasing competitiveness and economic growth not only at national level, but regionally as well (Goschin, 2014).

One key problem of the Romanian R&D system continues to be its fragmentation, combined with “a lack of critical mass in terms of the quality of research results, poor governance and weak coordination between research and innovation policy and other policies, as well as very weak links between education, research and the business sector” (European Comission, 2012).

The current status of the Romanian RDI system, which ranks among the least successful countries in EU for most of the performance indicators (PRO INNO, 2013), is an indication of deficiencies in designing and implementing the R&D strategies.

In this context, our paper aims to assess the time required to close the gaps in research and development between Romania and the EU by means of catching-up computational methods. We analyze the likelihood of equalizing EU average using data on various indicators in the R&D field, under different scenarios: pessimistic, realistic and optimistic.

The reminder of the paper proceeds as follows. Section 2 explains the catching-up computational methods to be employed in this paper. Section 3 presents the results on the time required for Romania to equalize EU average, for various indicators in the R&D field, over 2006-2013, while section 4 concludes.

2. Catching-up computational methodology

A key objective of regional policies is to close the social and economic gaps, therefore a host of methods for analyzing the catching-up process emerged, starting from the seminal works of Veblen (1915) and Gerschenkron (1962). More sophisticated models have been developed in time: Nelson and Phelps (1966) firstly used partial adjustment, Bruno (1993) addressed the specific nature of convergence and divergence in the labour productivity field, Benhabib and Spiegel (1994) further developed the partial adjustment mechanism of catching-up, etc.

More recently Lackenbauer (2004) identified relevant R&D factors for Hungarian EU convergence, Bentzen (2005) applied catching-up models for time series and periods characterized by different convergence rates; Havlik (2005) found that highly productive sectors enable higher convergence within EU-15; Peri and Urban (2006) addressed the impact of FDIs on technological level of developing countries.

The catching-up models are based on the hypothesis that if a less developed region/country has a rapid economic growth (higher than average) it is possible to catch-up with another region/county or the average level of a certain indicator. The catching-up computational methods allow for determining either the time necessary to recover a certain gap or the mean growth rate needed for an underdeveloped region to fill the gap over a certain period of time.

Given that a region \(i\) is placed under the national average for a certain indicator \(y\), but displays a more rapid annual growth index (\(y_0 < y_0\) and \(I_i > I\)), it might reach the average over a time interval \(t\):

\[
y_{i1} = y_1, \text{ where: } y_{i1} = y_0(I_i)\quad \text{and} \quad y_1 = y_0(I)\quad (1)
\]

\(^1\) For instance, the Romanian 2007-2013 Strategy for Research, Development and Innovation has foreseen a gradual increase of the R&D public budget.
It results from the previous relations that:
\[ y_0(I)^i = y_0(I)^i, \]  
(2)
and the unknown index \( I_i \) might be determined based on logarithms of equation (2):
\[ \log y_0 + t \log I_i = \log y_0 + t \log I, \]  
(3)
therefore:
\[ \log I_i = \log I + \frac{\log y_0 - \log y_0}{t}. \]  
(4)
Finally, the average annual growth index \( I_i \) needed for the underdeveloped region \( i \) can be computed and the additional resources required for reaching this target can be provided.

If the goal is to determine the time necessary to recover a certain gap (for instance, to catch up with the national average of indicator \( y \)), \( t \) can be computed from equation (3), as follows:
\[ t = \frac{\log y_0 - \log y_0}{\log I_i - \log I}. \]  
(5)
We are going to apply these catching-up computational methods in order to assess both the time necessary to recover a R&D gaps separating Romania from EU-28 and the average annual growth rate that would allow Romania to close the gaps in a certain period of time, under different scenarios (pessimistic, realistic and optimistic). To this aim we used the average annual growth over 2005-2012 and the level of individual indicators in 2012 as initial information and assumed that future growth in R&D sector will follow the same trends.

3. Results and discussion

R&D statistics show higher than EU growth in Romania for three of the dimensions of the Summary Innovation Index, namely Human resources, Intellectual assets, Economic effects (Figure 2), making possible to recover the gaps only in these areas.

Our computations on the number of years necessary for Romania to reach the EU-28 average, yielded the following results: Human resources 4.16 years, Intellectual assets 13.79 years, Economic effects 19.9 years, while for the other five dimensions of the Summary Innovation Index (SII), Romania is unable for now to narrow the gaps because its rate of growth is slower than the European average.

As regards the Summary Innovation Index, efforts to equalize EU-28 average would be considerable since Romania should increase its annual SII rhythm of growth by four times, even in the pessimistic scenario of 30 years time horizon.
In order to reach a more in-depth insight, we selected from the variables included in the Summary Innovation Index those that had a rate of growth higher than EU-28: Percentage of youth aged 20-24 having attained at least upper secondary level education, Public R&D expenditures as % of GDP, License and patent revenues from abroad as % of GDP, Percentage population aged 30-34 having completed tertiary education, International scientific co-publications per million population. Only for these five indicators (out of a total of 25 variables) it is possible to determine the number of years necessary for Romania to reach the EU-28 level (Table 1) and the mean growth rate needed for Romania to recover the gap to EU-28 average (Table 2).

Table 1. Evolution of selected indicators and the number of years necessary for Romania to reach the EU-28 level

| Percentage of youth aged 20-24 having attained at least upper secondary level education | no years (t) |
|---------------------------------|-------------|
| EU                              | 2005 2006 2007 2008 2009 2010 2011 2012 |
| Romania                         | 76.0 77.2 77.4 78.3 78.3 78.2 79.6 79.6 |

| Public R&D expenditures as % of GDP |
|------------------------------------|
| EU                                 | 2005 2006 2007 2008 2009 2010 2011 2012 |
| Romania                            | 0.20 0.23 0.31 0.41 0.28 0.28 0.31 0.30 |

| License and patent revenues from abroad as % of GDP |
|---------------------------------------------------|
| EU                                                 | 2005 2006 2007 2008 2009 2010 2011 2012 |
| Romania                                            | 0.05 0.03 0.02 0.12 0.12 0.28 0.13 0.14 |

| Percentage population aged 30-34 having completed tertiary education |
|-------------------------------------------------------------------|
| EU                                                          | 2005 2006 2007 2008 2009 2010 2011 2012 |
| Romania                                                      | 11.4 12.4 13.9 16.0 16.8 18.1 20.4 21.8 |
The average annual growth rate that would allow Romania to close the gaps to European average level in a certain period of time, was estimated under different scenarios: pessimistic (30 years, therefore the resulting rate was the lowest), realistic (15 years) and optimistic (5 years, which required the highest rate of growth). Although the indicator “License and patent revenues from abroad as % of GDP” was the most dynamic over 2005-2012, our estimations show that an extremely rapid growth rate (almost 43% annually) would be necessary under the optimistic scenario of 5 years. Such high growth rate is required because of the large existing gap, but is most likely unattainable. Instead, the realistic scenario of 15 years seems plausible, considering that only two additional percentage points above the current rate of growth are required.

### Table 2. Mean growth rate needed for Romania to recover the gap to EU-28 average for selected indicators

| Indicator                                                      | 2005-2012 mean annual rate | Necessary annual growth rate to recover the gap in: |
|---------------------------------------------------------------|----------------------------|---------------------------------------------------|
| Percentage youth aged 20-24 having attained at least upper secondary level education | 0.66                      | 0.53 0.56 0.66                                   |
| Public R&D expenditures as % of GDP                           | 5.96                      | 5.00 8.26 22.33                                 |
| License and patent revenues from abroad as % of GDP           | 16.13                     | 12.66 18.12 42.71                               |
| Percentage population aged 30-34 having completed tertiary education | 9.70                      | 5.30 7.06 14.38                                 |
| International scientific co-publications per million population | 10.87                     | 8.32 10.73 20.91                                |

As regards the indicator “Percentage youth aged 20-24 having attained at least upper secondary level education”, the optimistic scenario of 5 years for closing the gap seems easy to achieve since the needed rate of growth equals the actual rate in the previous period (Table 2).

International scientific co-publications per million population might recover the gap in 15 years with no additional effort, but would need to double the speed of growth to attain this goal in only 5 years.

The annual rate of growth for “Public R&D expenditures as % of GDP” would need 2.3 percentage points increase to close the gap to EU-28 in 15 years, while the optimistic scenario of 5 years seem difficult to reach (Table 2).

In sum, the realistic scenario that implies a 15 year horizon for attaining the European average is the most plausible for the selected set of indicators. Unfortunately, the rest of 20 indicators included in the Summary Innovation Index are not subject to possible catching-up for the time being.

### Conclusions

Although Romanian national strategies acknowledge R&D as a priority sector, up to now there is low convergence of the Romanian R&D system with the European one and the gaps remain large. In this context, our paper assessed the time required to close the gaps in research and development between Romania and the EU, as well as the mean growth rate needed for Romania to recover the gap to EU-28 average. We analyze the likelihood of equalizing European level in the R&D field for those indicators that had a higher than EU-28 growth over 2005-2012. The necessary growth rate to achieve this goal is estimated under different scenarios: pessimistic, realistic and optimistic. We found that the time span required to fill the Romanian R&D system’s gaps against EU varies between 5 and 25 years, depending on the indicator considered. Unfortunately, there are also R&D indicators for which the gaps got larger over the period under consideration, therefore catching-up seems for now unlikely.
The persistence of R&D inequalities calls for adequate policies able to underpin faster development of the Romanian RDI system, so that it may be effectively integrated in the European Research Area and Innovation Union and able to contribute to economic recovery and growth.

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References

Benhabib J., M. Spiegel, 1994, “The Role of Human Capital in Economic Development: Evidence from Aggregate Cross Country Data”, Journal of Monetary Economics, 34, 143–173.

Bentzen Jan, 2005, “Testing for catching-up periods in time-series convergence”, Economics Letters, Elsevier, Vol. 88(3), pages 323–328, September.

Bruno A., 1993, “Catch-Up and Convergence: A Model of Cumulative Growth”, International Review of Applied Economics, Taylor and Francis Journals, Vol. 7(1), pages 1–25.

David Paul A.; Bronwyn H. Hall, Andrew A. Toole, 2000, “Is Public R&D a Complement or a Substitute for Private R&D? A Review of the Econometric Evidence”, Research Policy, 29, 497–530.

European Commission, 2010. European Commission Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Europe 2020 Flagship Initiative, Innovation Union, SEC (2010) 1161 Brussels

European Commission, 2012: Key areas: comparing Member States’ performance, Europe 2020 Targets: Research and Development, http://ec.europa.eu/europe2020/pdf/themes/12_research_development.pdf

European Commission 2014, Europe 2020 Headline indicators http://ec.europa.eu/europe2020/pdf/headline_indicators_en.pdf

Gerschenkron A., 1962, Economic Backwardness in Historical Perspective, Belknap, Cambridge, MA.

Government of Romania, 2006. National Research, Development and Innovation (RDI) Strategy 2007-2013.

Government of Romania, 2011. Innobarometer report. Barriers to innovation report (in Romanian), http://www.roinno.ro/pdf/studiu_inobarometru.pdf.

Klette Tor Jakob, Jarle Moen, Zvi Griliches, 2000, “Do Subsidies to Commercial R&D Reduce Market Failures? Microeconometric Evaluation Studies”, Research Policy, 29, 471–496.

Lackenbauer Jorg, 2004, Catching-up, Regional Disparities and EU Cohesion Policy: The Case of Hungary, Managing Global Transitions, University of Primorska, Faculty of Management Koper, Vol. 2(2), pages 123–162.

Nelson R., E. Phelps, 1966, “Investment in Humans, Technological Diffusion and Economic Growth”, American Economic Review, 61, 69–75.

OECD, 2012. Science, technology and Industry Outlook, 2012: Innovation in the crisis and beyond

Peri Giovanni, Dieter Urban, 2006, “Catching-up to foreign technology? Evidence on the 'Veblen-Gerschenkron' effect of foreign investments”, Regional Science and Urban Economics, Elsevier, Vol. 36(1), pages 72–98, January.

PRO INNO Europe, 2014. Innovation Union Scoreboard 2014, http://ec.europa.eu/enterprise/policies/innovation/policy/innovation-scoreboard/index_en.htm.

Ranga, M., 2010. Policy Paper on Innovation - Romania, Expert Evaluation Network Delivering Policy Analysis on the Performance of Cohesion Policy 2007-2013.

RO INNO Romania, 2011. Innobarometer report. Barriers to innovation report (in Romanian), http://www.roinno.ro/pdf/studiu_inobarometru.pdf.

Sandu, S., 2010. Main Issues of R&D Financing in Romania, Romanian Journal of Economics, Institute of National Economy, vol. 30(1(39)), 127-145 http://ideas.repec.org/a/ine/journl/v1y2010i39p127-145.html

Sandu, S., Zaman, G., Goschin, Z. and Constantin, D.L., 2010. A Composite Index of R&D Absorption Capacity. Spatial Configuration in Romania, Economic Computation and Economic Cybernetics Studies and Research, Vol. 44, No.1, pp.5-20.

Sandu, S., 2010. Main Issues of R&D Financing in Romania, Romanian Journal of Economics, Institute of National Economy, vol. 30(1(39)), 127-145 http://ideas.repec.org/a/ine/journl/v1y2010i39p127-145.html

Sandu, S., Zaman, G., Gheorghiu, G., Modoran, C., 2008. An assessment of research system and policies in Romania, ERAWATCH Country Report.

Sandu, S., Paun, C. 2010. Assessing the Possibilities of Filling the Gap Between Romania and the EU in the RDI Field, Working Papers of National Institute of Economic Research.

Sandu, S., 2011. Convergence of Romanian R&D System within Innovation Union, Apas Papers, Academic Public Administration Studies Archive 377, http://ideas.repec.org/p/nsu/apasro/377.html.
Seidel Hans, 1995, Economic Growth and Convergence, WIFO Monatsberichte (monthly reports), WIFO, Vol. 68(1), pages 48–62, January.

Stehrer Robert, 2002, “Dynamics of Trade Integration and Technological Convergence”, Economic Systems Research, Taylor and Francis Journals, Vol. 14(3), pages 219–244, September.

Taskin Fatma, Osman Zaim, 1997, “Catching-up and innovation in high- and low-income countries”, Economic Letters, Elsevier, Vol. 54(1), pages 93–100, January.

Warda J., 2001, “Measuring the Value of R&D Tax Treatment in OECD Countries”, STI Review No. 27, OECD, Paris.