Performance Assessment of Belgian Researchers

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2 April, 2012

Performance evaluations and rankings have become all pervasive. Rating agencies are evaluating countries and banks, consulting agencies are assessing the performance of companies, human resource offices are evaluating their workers. The evaluation culture has invaded all aspects of our life; only evaluators appear to have escaped this evaluation frenzy. Historians will perhaps remember the start of the 21st century as a period where more effort was spent on evaluating than on producing.

In the universities also, the evaluation culture is present everywhere. The universities are compared by the famous rankings (Shanghai, Times Higher Education, etc) while the professors are evaluated at every step of their career, whether it is for a promotion or for an application to research funding.

The criteria are constantly revised, in part because every new evaluation criterion leads to adaptation strategies. As soon as the research community finds out that a particular research performance criterion becomes dominant in the evaluation committees, some of its members adapt their research and publication strategy to maximize its impact on the newly adopted criterion rather than aiming at producing the most highly creative research results. For a while it was the number of publications that mattered until it became obvious that it is easy to publish many papers in low quality journals. After a period in which the assumed quality of the journals was taken into account, as measured, for example, by the infamous impact factors, the trend in the last 5 to 10 years has been to consider the number of citations[1] of a document (book, book chapter, journal article, conference paper) as the most important measure of research performance for a researcher. The idea is that if a paper is highly cited by researchers in the same field, it is probably because it contained important new ideas; conversely, if a paper is never cited, it probably means that it was not deep or ground-breaking.

Today, the number of citations has become accepted as the leading indicator for the evaluation of research quality, at least in fundamental research. It is encapsulated in a number of criteria that have been devised to produce the most compact possible measure of performance, the most notorious one being the *h-index*. A researcher has an h-index of 20, say, if 20 of his/her publications have been cited at least 20 times. A productive researcher will proudly exhibit his/her h-index, while the researcher who is less well endowed will hope that his/her evaluation committee will not look it up on the specialized websites. One should add that publication rhythms and citation traditions vary widely between disciplines, and that one can never compare citation records or h-indices across disciplines.

The use and misuse of the h-index in the evaluation of researchers is widely criticized within the research community and rightly so, because the maximisation of one's h-index often conflicts with the pursuit of long-term visionary research. Evaluation committees like to make their life simple and they therefore long for a unique indicator that would allow them to rank researchers without any effort, rather than facing the hard task of evaluating the creativity, depth and impact of the contributions of these researchers by themselves. In addition, the dominance of a single performance indicator inevitably produces perverse effects among some members of the research community. Just to give one example, some journals now request the authors to cite other authors who have published in the same journal so as to increase the citation record of that journal. I want to make it clear that one should keep a very critical eye on the use and abuse of the h-index and other sophisticated performance indices that are being constantly devised or refined.

Keeping in mind the cautionary remarks made above, but given that the number of citations has become so prevalent in the evaluation of fundamental research all over the world and that it is indeed one important indicator of the impact of a research paper or book within a scientific discipline, I have found it interesting to compare these citation numbers for 17 OECD countries[2] that are considered to be among the most active research-wise. All the analyses in this report have been performed using

[1] A scientific publication is "cited" if another scientific publication refers to it.

[2] Australia, Belgium, Canada, China, Denmark, Finland, France, Germany, Israel, Italy, Japan, Netherlands, Spain, Sweden, Switzerland, UK, USA

data available from the websites of the World Bank[3], the OECD[4] and SCImago[5], a website that is specialized in the ranking of journals and countries on the basis of citations of papers and that is powered by SCOPUS[6], a data-base of scientific documents and citations maintained by Elsevier. The data in this report do not use the h-index, but citation numbers of documents produced by the 17 countries.

On the SCImago website one can compute citation numbers of documents published in all possible countries over the period 1996-2010, or separately for each year of that period. The number of citations given for a specific country and for a particular year X is the number of citations of all papers published by authors of that country during the year X and cited during the years X, X+1, X+2, etc, until 2010. Thus, the citation numbers for the year 2008, say, refer to the number of citations of all documents published in 2008 and cited in 2008, 2009 or 2010. When referring to the period 1996-2010, all documents published during that period are considered.

A comparison between countries based on the total number of citations would not be meaningful, of course, because it would not take account of the size of the population of the countries involved, the number of researchers, or the budgets allocated to research. In order to compare countries of such varying populations, one needs to introduce some normalization. In this study, different types of normalization have been introduced: in the first, the number of citations per document produced by authors of the 17 countries are examined; in the second, the number of citations of a country are divided by the budgets allocated to research in higher education institutions of that country; in the third, an index called Normalized Impact (NI) is studied, which will be explained later.

Citations per document

The first normalized data represent the average number of citations per document for the 17 countries involved. In order to evaluate whether the scientific performance, as indicated by this citations-per-document ratio, has evolved over the years, these normalized data have been computed first for the period 1996-2010, and then separately for the years 2009 and 2010. This allows one to check whether the relative position of Belgian researchers with respect to those of the other 16 countries is in progress or is receding. The next picture shows the ranking of the 17 countries over the long period (1996-2010).

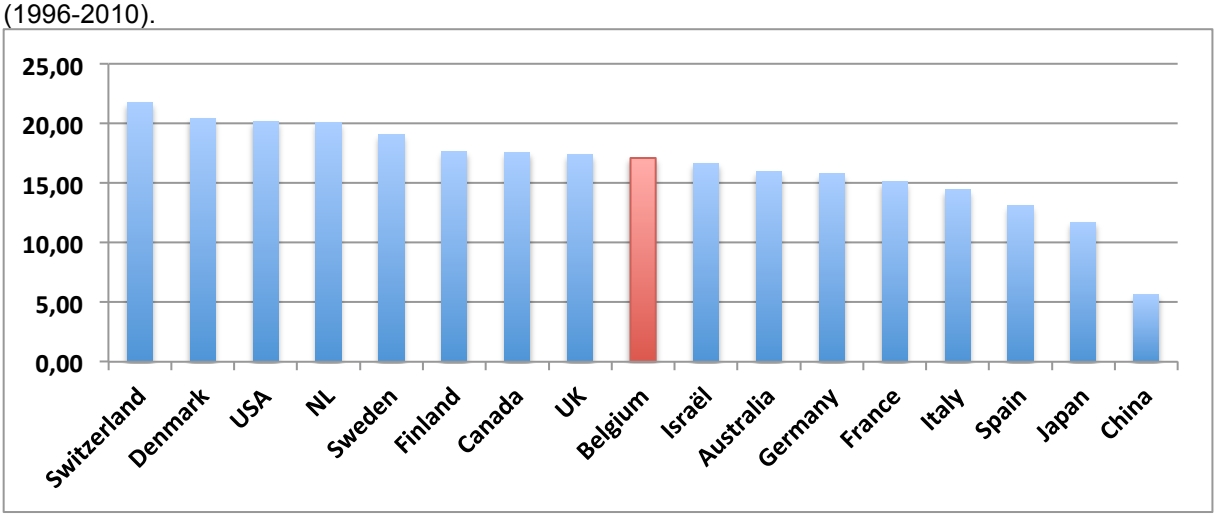

Figure 1: Average number of citations per document for the period 1996-2010

We observe that Belgium sits in 9th position for the average number of citations per document over the period 1996-2010. In order to check the evolution of this indicator, I have computed the rankings for the year 2010. These are shown in Figure 2. What is remarkable is that the relative position of Belgium in this ranking climbs to the 5th position. One should bear in mind that for 2010, these rankings are based on much smaller citation counts, since only papers published and cited in 2010 are

[3] http://data.worldbank.org
[4] OECD= Organisation for Economic Co-operation and Development: http://www.oecd-ilibrary.org/
[5] http://www.scimagojr.com
[6] http://www.scopus.com/

taken into account; in many disciplines, the publication deadlines are much longer than one year. Hence the variance of these numbers is high.

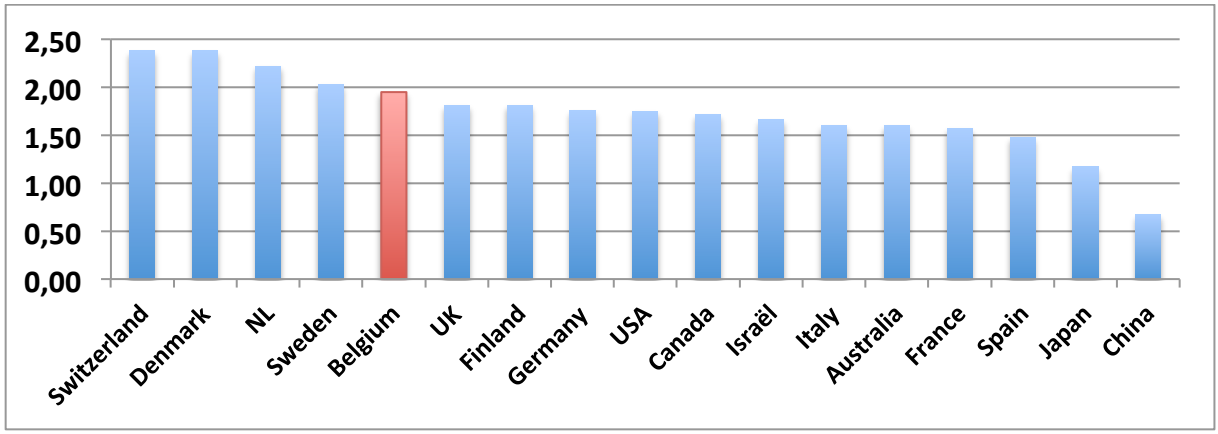

Figure 2: Average number of citations per document in 2010

In order to make sure that Belgium has indeed made significant progress, I have therefore considered the relative position of Belgium for the citation numbers of papers published every year from 1996 to 2010. The result is shown in Figure 3.

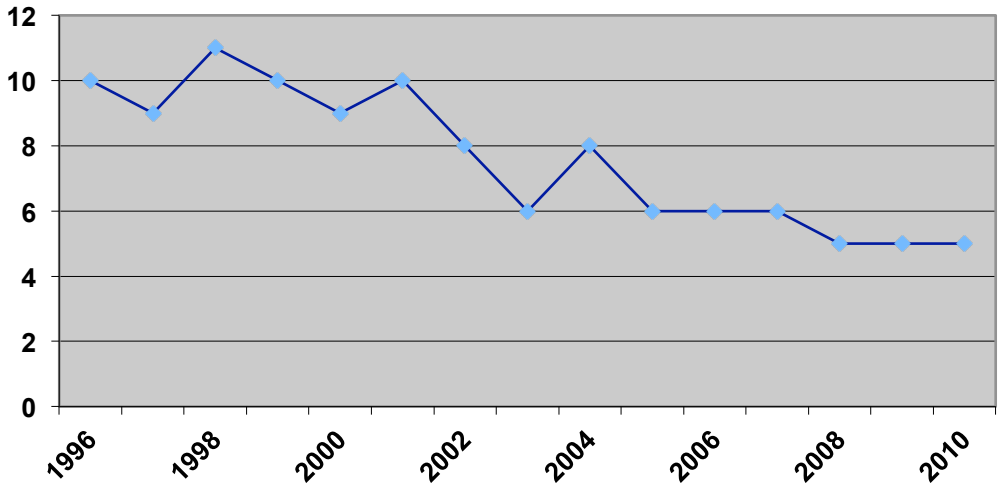

Figure 3: Citation per document: ranking of Belgium with respect to the 17 countries

The figure shows that the ranking of Belgium has improved steadily over the years; thus the comfortable 5th position in 2009 and 2010 is no accident.

The analysis can actually be fine-tuned by performing these rankings of citation numbers per document not just for all documents published by Belgian researchers, but discipline by discipline. Table 1 shows the ranking, with respect to the 17 countries mentioned earlier, of Belgian researchers for a range of disciplines, and for three different periods: the rankings in green are computed for the long period (1996-2010), those in blue for the documents published in 2009, and those in black for the documents published in 2010. One should again bear in mind that the rankings for 2010 are based on much smaller numbers than those for the long period. This is the reason why the data were also computed for 2009, so as to make sure that the significant progress evidenced by the 2010 data were not just an artefact due to the high variance of the 2010 data. This figure shows a clear trend forward for Belgian researchers as a whole (moving from 9th to 5th place), but it also shows the excellent position of Belgian researchers in a range of disciplines, in particular in dentistry, computer science, decision sciences, and business sciences, as well as important progress in medicine, microbiology, engineering, environmental science and, particularly, in neuroscience.

Subject Area	Rank
All	**9/5/5**
Medicine	8/4/4
Pharmacology &Toxicology	8/1/6
Earth and Planetary Sc.	11/3/6
Mathematics	6/1/6
Neuroscience	8/2/1
Biochem., Genetics & Molec.	9/4/9
Dentistry	1/5/1
Health Professions	2/2/6
Immunology and Microbiology	7/6/4
Physics and Astronomy	13/11/10
Veterinary	14/4/6
Chemistry	11/9/12

Subject Area	Rank
Computer Science	5/3/2
Economics, Econometrics and Finance	8/1/8
Engineering	6/6/4
Arts and Humanities	14/7/5
Psychology	4/4/6
Agriculture and Biol. Sc.	7/8/7
Decision Sciences	1/6/2
Environmental Science	9/6/3
Social Sciences	7/4/2
Chemical Engineering	6/5/6
Materials Science	7/7/7
Business, Management & Accounting	5/2/3

Table 1: Belgium's Rankings : citations per document
1996-2010/2009/2010

Citations normalized for investments

A second way of producing comparisons between countries of very different sizes is to examine the return on investment. Given that citation counts are really a measure that reflects the scientific performance of fundamental research (industrial Research and Development is typically less conducive to publications), we have considered the investments of the 17 countries of this study in Higher Education Research and Development (referred to as HERD by the OECD). Figure 4 shows the percentage of GDP spent by our 17 countries in HERD. As can be seen Belgium sits here in a rather modest 11th position.

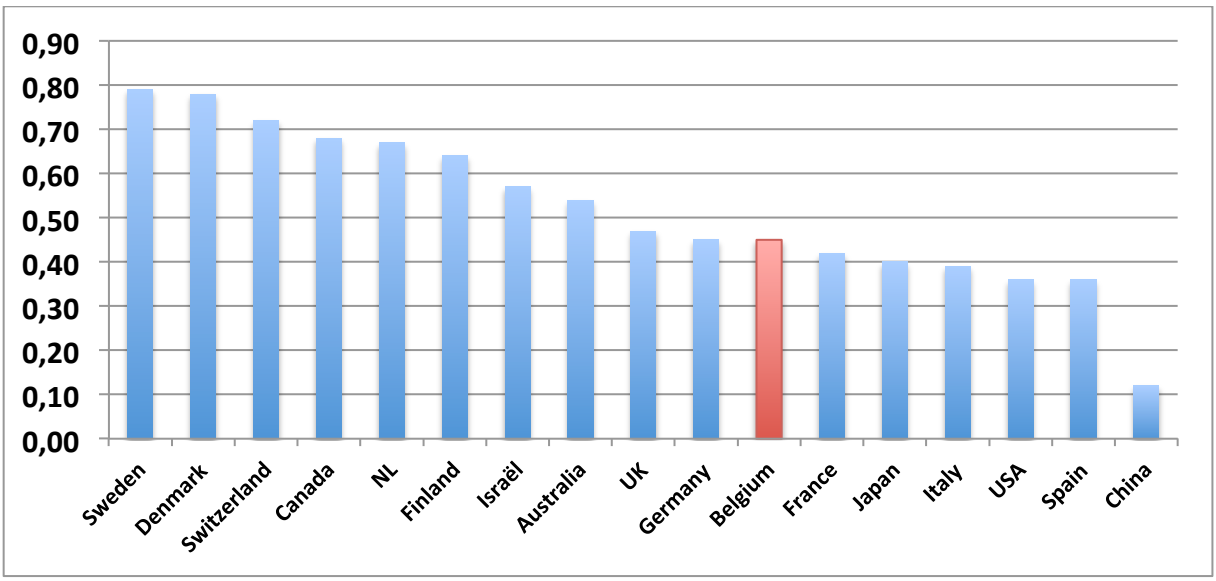

Figure 4: Higher Education R&D as a percentage of GDP in 2008

We observe here that, as is well known in the scientific community, the Scandinavian countries rank very high in the percentage of their GDP that is invested in research in Higher Education institutions, and so do Switzerland and The Netherlands.

In order to evaluate the return on investment, the number of citations produced in 2010 are divided, for each country, by the investment in HERD in 2008, thus allowing for some lag between investment and a measure of its return. The results, which are a measure of research efficiency, appear in Figure 5.

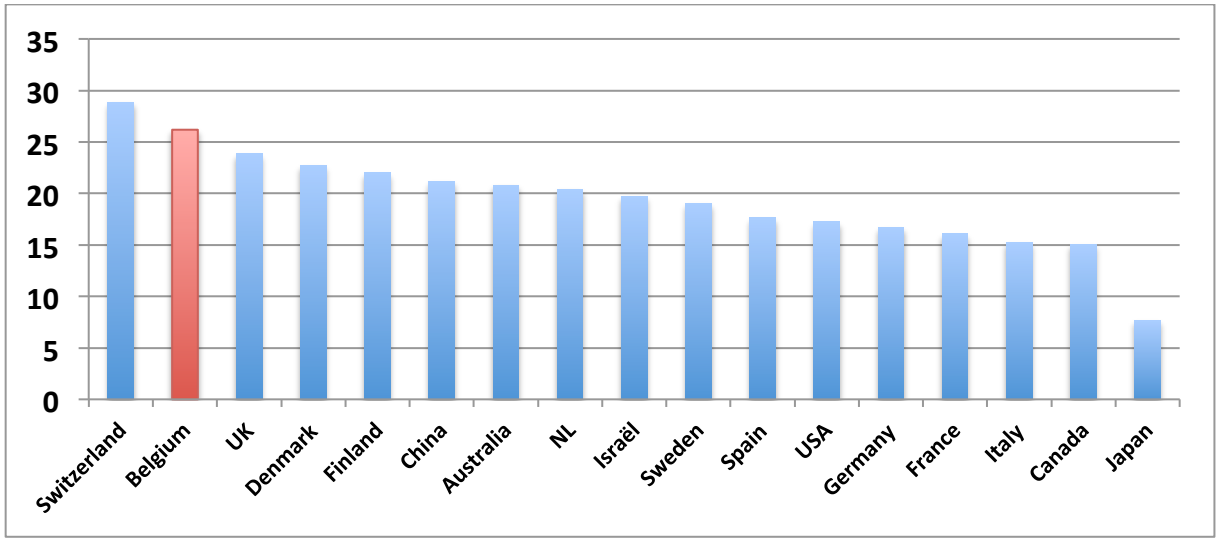

Figure 5: number of citations in 2010 versus HERD investment in 2008

These results are truly remarkable, because they show that for this particular measure of research efficiency, Belgian researchers are preceded only by their Swiss counterparts, and that they are way ahead of countries like the US, France and Japan, which all have a long tradition in fundamental research.

Remembering again the high variance on the citation numbers for 2010, I wanted to check whether this remarkable result for Belgium was not the result of an artefact: would it be possible that Belgian researchers had been exceptionally well cited by their colleagues worldwide in 2010? In order to test this possibility, the same calculations have been performed by shifting all data two years backwards. Thus, Figure 6 presents the same analysis as Figure 5, but it now divides number of citations in 2008 by HERD investment in 2006.

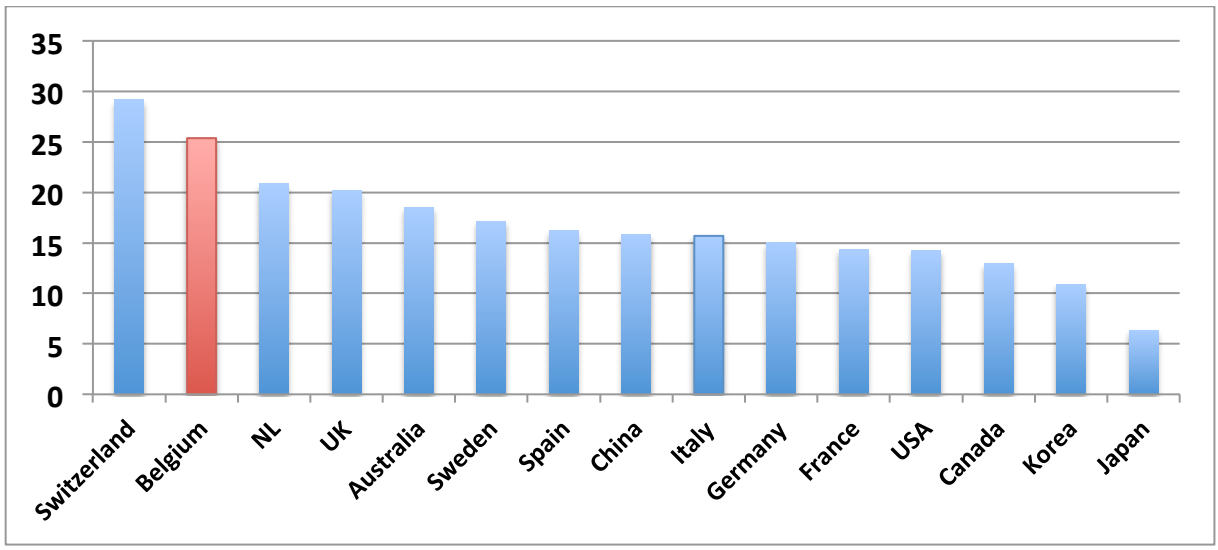

Figure 6: number of citations in 2008 versus HERD investment in 2006

The position of the first two countries is unchanged: Switzerland ranks #1, immediately followed by Belgium. At the end of this report some hypotheses will be suggested that might explain this unexpected efficiency of Belgian research.

Ranking by the Normalized Impact

As I was concluding this study, I discovered some interesting results comparing the citation numbers of Higher Education Institutions (almost all of them universities) in 50 countries worldwide, produced by Professor Félix de Moya Anegon, a Spanish researcher specialized in research performance indicators. In his study he used the so-called Normalized Impact (NI) indicator devised by researchers at Karolinska University in Stockholm. The Normalized Impact compares the scientific impact, measured by citation numbers, of a Higher Education institution with the world average in the same scientific domain and over the same period, while taking account of the size of that institution.

The chart shown below in Figure 7, produced by Prof. de Moya Anegon, shows impressive results for the Belgian universities. Indeed, Belgium is one of a very small group of countries where all universities rank above the world average, in fact well above, since the median for Belgium is at 1.4, i.e. 44% above the world average of 1. In addition, the spread between the Belgian universities is very narrow, ranging from 1.64 for the top one to 1.34 for the "least productive". This spread is the smallest of the 50 considered countries

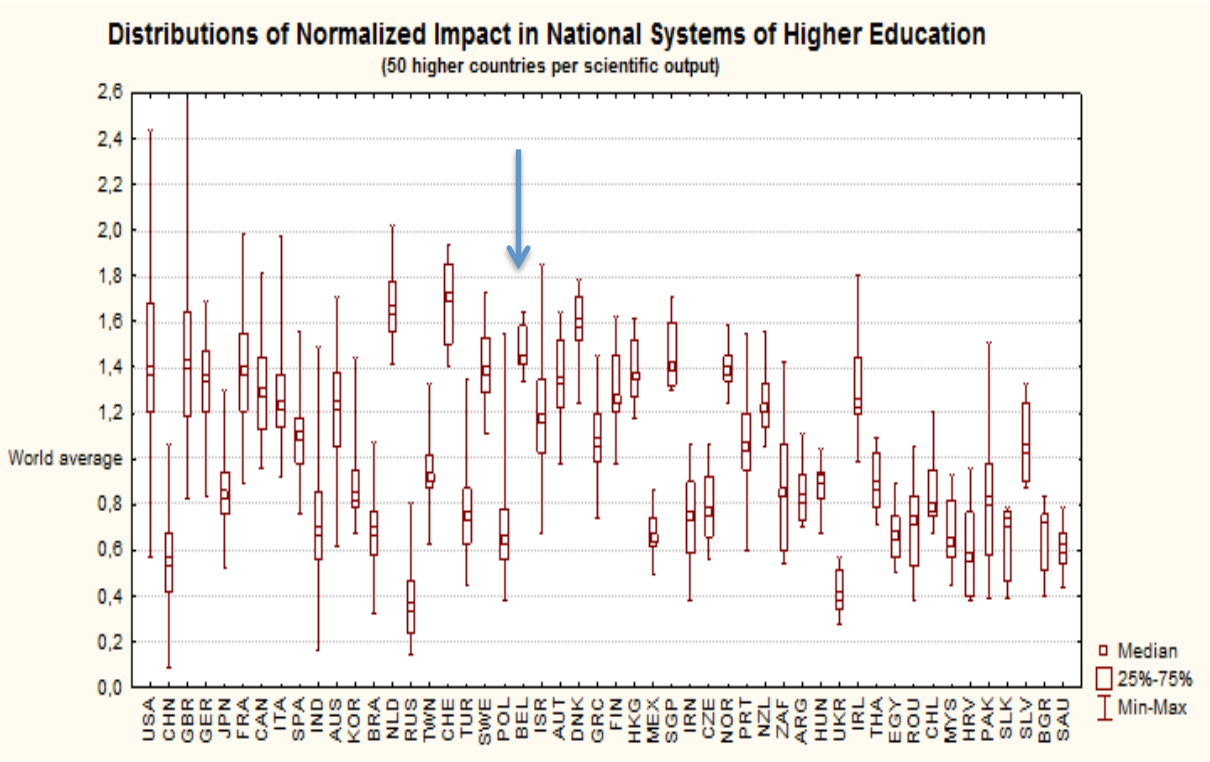

Figure 7: comparison of Normalized Impact for Higher Education institutions of 50 countries

which shows a great homogeneity at a high quality level of all our universities. As pointed out by de Moya Anegon in his report, two countries are very homogenous, Belgium in the top half, and Ukraine in the bottom half.

Professor de Moya Anegon was kind enough to provide information on the universities involved in his study. In doing so, he also sent Figure 8 and Table 2 below showing the evolution of the Normalized Impact for the Belgian universities considered in his worldwide study (those that publish at least 100 papers every year, he mentioned). These results confirm that the Belgian universities are very close to each other, and all well above the world average. But in addition they show that they are all making progress year after year. These figures thus reinforce the earlier findings of this report, based on citations per document, that the scientific impact of Belgian researchers is steadily climbing. As a cautionary note here, one should add that the citation numbers of the Institute of Tropical Medicine should not be compared with those of full-fledged universities, because publication and citation habits can vary widely between disciplines; thus one cannot compare citation numbers in medicine with those of universities that cover a very wide range of disciplines.

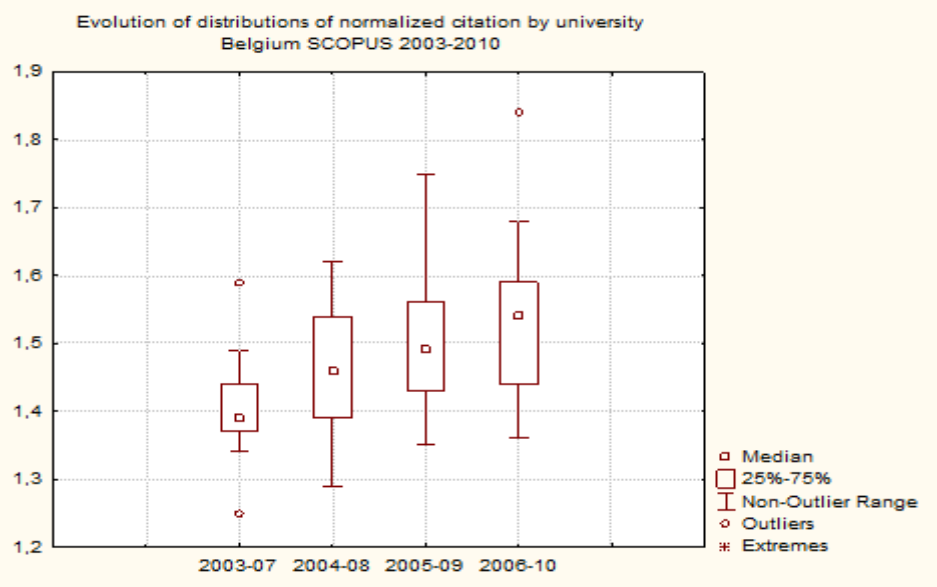

Figure 8: evolution of the NI of Belgian institutions over the period 2003 to 2010

Institution	2003-2007	2004-2008	2005-2009	2006-2010
Catholic University of Leuven	1,59	1,62	1,65	1,68
Catholic University of Louvain	1,49	1,54	1,56	1,59
Institute of Tropical Medicine Antwerp	1,44	1,60	1,75	1,84
Université Libre de Bruxelles	1,39	1,40	1,49	1,54
University of Antwerp	1,39	1,46	1,49	1,56
University of Mons	1,38	1,47	1,45	1,44
Ghent University	1,37	1,39	1,43	1,50
Vrije University Brussel	1,34	1,39	1,41	1,42
Université de Liège	1,25	1,29	1,35	1,36

Table 2: evolution of the Normalized Impact from 2003-07 to 2006-10

Success with ERC grants

In 2007, the European Union started a highly competitive funding programme for fundamental research, managed by the newly created European Research Council (ERC). The budgets for these new grants are growing steadily, with two types of grants: Starting Grants for young researchers and Advanced Grants for senior researchers. A recent study[7] performed by FNRS shows that Belgium ranks 5th in the number of grants obtained normalized to the size of the population, after Switzerland, Israel, The Netherlands and Sweden, and ahead of the UK, France, Germany, Spain and Italy.

[7] Julie Van Rossom, "L'ERC en chiffres" in FNRS News No 87, December 2011: http://www2.frs-fnrs.be/SITE2/Lettre/media/lettre87.pdf

Possible explanations

If one wants to find possible causes as to why the productivity of our fundamental research ranks high above that of most other important OECD countries, then one route is to examine what is specific in the organisation of research in Belgium compared to most other countries.

One specificity of the Belgian organisational structure is that almost all publicly funded fundamental research is performed at the universities, and that they benefit from a large autonomy in their decision making process and their strategic research policies. Unlike in countries such as France, Germany, or Italy, the research organisations like FWO (Fonds voor Wetenschappelijk Onderzoek) and FNRS (Fonds National de la Recherche Scientifique) are bringing complementary resources to the universities, rather than creating competing research centres, thereby avoiding a dispersion of resources. In addition, both FWO and FNRS focus most of their effort on the funding of high quality researchers rather than on research programmes, which in the long run is the best way to build a high level of competence in Belgium.

A second specificity is the presence of a number of high quality universities in a small territory like Belgium, which is highly conducive to collaborative research. It should be observed that other small countries like Switzerland, Denmark and The Netherlands rank high in most of the performance indicators we have examined.

And this leads to what is perhaps the most important explanation for the high efficiency of Belgian researchers and for the significant progress observed in the rankings over the last 15 years: the creation in 1988 of the Interuniversity Attraction Poles (IAP). This is a programme of fundamental research, organised at the federal level, by which networks have been set up in the disciplines in which Belgian research teams have already reached international status. Each network must by law contain teams from both the Flemish and the French community. Every network is evaluated at the end of each 5-year phase by a panel of international experts of the domain of the network.

The IAP programme has been evaluated in 2000 and again in 2010 by international panels of science policy experts. In 2000 the panel made some recommendations, but concluded that the IAP programme was so good that it should be continued even if none of its recommendations were implemented. The 2010 panel observed the remarkable increase in scientific quality that the networks had produced and noted in its report that “close to half of the networks are world-class, with some world-leading research being carried out.” Some networks have been described in this evaluation report as the leading research constellation in the world in their discipline. The progress accomplished by some IAP networks can be observed in terms of quantity and quality of publications, impact of these publications, and the creation of scientific environments that attract the best researchers in the world to Belgium.

Concluding notes

I wish to conclude this report on a personal note. I started this research because my attention drawn to these performance indicators by data coming from Italian colleagues and research organisations, and this triggered my curiosity. In the process of comparing research efficiency within the most active OECD countries, I discovered that Belgium punches much higher on the world scene of international research than could be explained by the budgets invested. This came as a total surprise to me. Having considered various hypotheses that might explain this success, it appears to me, retrospectively, that the existence of the IAP programme must be a major cause for this performance.

This being said, I wish to conclude with two recommendations based on 40 years of experience as an active member of the Belgian research community, with periods of several years spent in Australia and the US, as a coordinator of an IAP network for 20 years, and as an active participant in selection committees for the FNRS, the FWO and the Research Council of UCL.

The first is to address a warning to those who might be tempted to say that, since Belgian researchers perform so well despite small research budgets, there is no real need to increase them. It so happens that the number of world-class researchers has increased so much in the last two decades in Belgium that the present research funding levels are unable to fund many of them. The budgets for the new phase of the IAP programme have been decided just last week: some IAP networks, that have

become world leading, are now receiving budgets that are much smaller than what they received 10 years ago. Similarly, the budgets allocated by the two community governments for Concerted Research Actions (GOA-ARC) have become totally insufficient to fund the growing number of teams within the universities that have achieved international status. Thus, both the IAP programme and the Concerted Research Actions should see their budgets significantly increased if Belgium is to maintain its position. It takes 15 years to build up a top-level network with critical mass of world-class competence; it only takes a few years to dismantle it. It is also important to recognize that the IAP programme is the only funding mechanism by which researchers from our two communities are able to collaborate, and that the present level of such collaborations is very high.

The second recommendation is that it would be a major mistake for our policymakers to make major changes to the organisational structure of our university system or to research programs that are proving to be so remarkably efficient despite the modest public investments in research. When it comes to fundamental research and to the performance of our universities, Belgium has a remarkable return on investment. Never change a winning organisation!

In closing, I wish to thank my colleague at the VUB, Professor Vera Rogiers, for fruitful discussions on the findings of this report.

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