Innovation for Growth – i4g

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Innovation and the public research organization in the ERA

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Findings

1. The European Research Area (ERA) is characterized by a high degree of diversity in terms of national public research systems expressed in higher education institutions (HEIs) and in public research organisations or public non-university institutions (PROs).
2. Europe has to benefit from the diversity of its institutional research arrangements in order to improve the performance of the research system in view of academic excellence and particular in view of innovation.
3. To improve knowledge exchange and innovation in Europe, monitoring of HEIs and PROs has to be expanded and better indicators for the knowledge transfer and the innovation system has to be developed.

Recommendations

- **Support successful institutions in each national system instead of creating similar institutional set-ups all over Europe;**
- **Strengthen research universities;**
- **Create or maintain only those PROs that fulfil a mission that cannot be accomplished at a research university;**
- **Set up a European-wide monitoring system for all public research institutions: HEIs and PROs;**
- **Include PRO's research performance in global university rankings;**
- **Develop better indicators for knowledge transfer and innovation activities for monitoring and management of the public research institutions.**

This report does not necessarily reflect the views of the European Commission. The findings are based on a number of previous presentations and a dedicated i4g workshop.

Innovation and the public research organization in the ERA: A comparison between Germany, France and the UK

Jutta Allmendinger and Marvin Gamisch

Introduction

This policy brief will take a closer look at public research organization and performance. It addresses the question: What kinds of research institutions or institutional arrangements are needed in Europe to bring out research excellence and foster innovation? The background of this question is that institutional arrangements of public research vary considerably between EU Member States with regard to the importance of the non-university sector. Do these different kinds of organization have specific advantages – and if so, what are they? Does a strong non-university sector lead to a more innovative research system? Has the German model, with its four major non-university research associations (Max Planck, Fraunhofer, Helmholtz and Leibniz institutes), contributed to the high innovative capacity of the German economy?

That this may be the case is suggested by the Innovation Union Scoreboard[1], which lists Germany as an 'Innovation Leader' and the UK as an 'Innovation Follower' although – according to academic excellence in world rankings of universities – the UK has clearly come out on top for at least a couple of decades.

The policy brief is based on the analysis of public data and empirical studies, as well as on a recent I4G workshop examining the research systems of Germany, France and the UK.[2] This paper assesses research performance and innovation ability against indicators of publication output, international alignment, citation rate, ERC grants, international rankings and patent output.

1. Research expenditure and performance in Europe, the US and Asia

[1]Cf. http://ec.europa.eu/enterprise/policies/innovation/facts-figures-analysis/innovation-scoreboard/index_en.htm.

[2] Innovation for Growth (I4G) Workshop 'Public research systems and innovation in Europe. Which kind of research institution/ arrangement of institutions do we need?' held on November 12, 2012, at the WZB Berlin Social Research Center.

Research and Development (R&D) has become a significant factor for the competitiveness of the economies in the OECD. The European Union's Lisbon strategy underlined this fact by setting a target of 3% GDP to be spent by EU Member States on R&D activities by 2010. The strategy envisaged 2% private R&D investment, destined to help boost innovation immediately as applied research and to serve as the driving force of modern economies. R&D investments for universities, by contrast, are seen as only loosely linked to innovation, because the emphasis there is mainly on fundamental or basic research that may take a long time to bear fruit for society and the economy. But is it truly the case that public non-university research institutions tend more towards applied research and therefore innovation?

The 2011 *Innovation Union Competitiveness Report* stated that the European public research system consists primarily of higher education institutions (HEIs) and public research organizations (PROs), which form the public non-university research sector. There are nearly 3,000 HEIs in Europe, including 1,360 research-performing HEIs and 170 highly research-intensive universities. There are no exact figures for non-university research organizations in Europe but the report identified at least 150 large PROs at this point. That, however, is a poor estimate for the number of PROs in Europe. Two-thirds of public institutional funds go to HEIs, whereas one-third goes to PROs. In the European-wide competition for research grants in the 6th Framework Programme, which was strongly geared to technology research, PROs in total performed only slightly less well than HEIs. They received a share of 30.6% of the budget, compared to 37.6% for HEIs.[3] Relative to their size and number, however, PROs performed much better than HEIs, a fact that supports the assumption that they may be more associated with innovation than HEIs.

In international comparisons of research performance, it is common to rely on **input indicators**, such as financial investment (e.g. the 3% target), and to measure **output indicators** such as the number of patents, publications, citations, awards or scores in international rankings. As only the public research landscape is considered, other indicators of innovation, such as high-tech exports or BERD (Business Expenditure on Research and Development), are excluded here.

With regard do **input indicators**, the EU-27 achieved a 2% R&D share of the GDP in 2010, an average notably below the 3% target. Germany achieved 2.82%, France 2.26% and the UK 1.77%. Only Finland, Sweden and Denmark managed to exceed the target, whereas the 'big' member states

[3] Cf. European Commission (2011), pp. 157-161.

are far from reaching it. In comparison, the US share was 2.79%, and China's share was 1.47% in 2008. Nonetheless, the 3% target does not seem so ambitious if one takes into account the shares of Japan (3.45%, 2008) and Korea (3.36%, 2008), innovative economies exporting mostly high-tech products.[4]

With regard to **research output**, a Fraunhofer ISI study offers a sophisticated international comparison. Drawing on the Web of Science (WoS), a multidisciplinary database of high-quality journals, it compares bibliometric analyses to indicate the R&D performance of selected countries, including the US, Germany, France, the UK, the EU average and others.

Over time, we observe considerable shifts in performance rates by country. The study reveals a moderate decrease in the relative performance of both the US and the EU. Between 2000 and 2009, the US share in all publications registered in the WoS declined from 32.1% to 28%; the EU-27 share went down from 37.2% to 35.6% Within the EU, Germany, France and the UK all witnessed a reduction of their world share. Germany's share declined from 8.1% to 7.3% in the same period, Britain's from 9.3% to 7.8%, and France's from 5.9% to 5.3%. The Netherlands and Italy, by contrast, could slightly improve their performance. Changing the focus to Asia, we observe a decrease of the Japanese share from 8.7% to 6.3%, whereas Korea could improve its performance from 1.6% to 3.1%. The most striking thing, though, is the tremendous rise of China from 3.5% to 10.3%.[5] Clearly, the European countries have to strengthen their efforts to keep up.

There are hardly any indicators to measure the performance of institutions, however. The 25 indicators of the Innovation Union Scoreboard (IUS) are tailor-made for countries, not for single institutions[6].

To approach the question of whether institutional designs matter, we consider three different systems. Germany, France and the UK will be compared with regard to their public research institutions. Both Germany and France are examples of a system with a highly developed non-university research sector, whereas the British system is dominated by research universities.

[4] Cf. EUROSTAT (2012), p. 32, and EFI (2012), pp. 20f.
[5] Cf. Schmoch et. al. (2011), p. 5.
[6] The IUS is differentiated into twenty-five indicators grouped into eight innovation dimensions and three main classes of indicators. The high levels of aggregations - the 8 innovation dimensions - already allow for a detailed picture and analysis of country group comparison. See: European Commission (2012).

2. The role of the public research systems of Germany, France and the UK for R&D performance and innovation with special emphasis on the non-university sector

2.1 Scope and structure of the public non-university research sector in Germany, France and the UK

Let us begin by looking at the role of the public non-university research sector in Germany, France and the UK. This look should enable us to identify the advantages and disadvantages of the different organizational research settings and their implications for innovation.

The size of the non-university sector varies between the three countries. In 2010, the GDP share of non-university public research was 0.41% in Germany, 0.37% in France and 0.17% in the UK. In other words, Germany and France are clearly above the EU-27 average of 0.26%, whereas the UK is far below it.[7]

Thanks to its highly developed non-university sector, **Germany** possesses an internationally unique research landscape. In 2010, a total of about €10 billion was spent on R&D in the German non-university sector. The expenditure adds up to 44.6% of total spending in the public research sector.[8] But the uniqueness is not necessarily in the scope but in the diversity of the non-university research sector, which currently encompasses 1,006 institutions. Some of them are clustered in the big four research associations: the Max Planck Society, the Fraunhofer Society, the Helmholtz Association and the Leibniz Association. In addition, there are academies, ministerial research organizations, libraries, archives, museums and other institutions.[9]

In 2010, the **French** non-university sector had an expenditure volume of €6.4 billion, which amounts to 43.5% of total public research spending.[10] Regarding its institutional composition, the French non-university sector is shaped by big organizational units like the National Centre for Scientific Research (CNRS) with over 25,000 employees, the Centre for Nuclear Power (CEA) with over 16,000 employees or the National Institute for Agricultural Research (INRA) with around 10,000 employees. Also notable are the 33 Carnot Institutes, which are responsible for the cooperation with enterprises and the transfer of technology. Some belong to other non-

[7] Cf. OECD (2012), pp. 75f.
[8] Cf. ibid., pp. 69 and 75f
[9] Cf. Federal Statistical Office Germany (2012), pp. 12-13.
[10] Cf. OECD (2012), pp. 69 and 75f

university organizations like the CNRS, whereas others are fully independent. In addition, France has ministerial research organizations.[11]

The R&D expenditure volume of the **British** non-university sector amounted to around €2.9 billion in 2010, representing only 26.1% of total R&D spending in the public research sector.[12] The non-university sector consists of about 140 so-called 'Public Sector Research Establishments' and is dominated by ministerial research institutions mainly dedicated to research in defence and health, which take up over half of the total public non-university R&D expenditure. The institutes of the Research Councils account for 30%; cultural institutions take up 4%. The degree of diversification is significantly lower than that of Germany and France. It is notable that R&D expenditures only constitute a small part of the total expenditure. In the case of the ministerial research institutions, it is only up to 17%.[13]

2.2 Research and innovation performance of Germany, France and the UK

To assess the research and innovation performance of the different systems, we consider the following indicators: number of publications, university rankings, international alignment, citation rate, ERC grants and patent output.

Number of publications

The 2011 World Report of SCImago provides information about the publication output of single HEIs and PROs. The report looks at 3,042 institutions worldwide that have published at least 100 scientific documents of any kind during 2009, as collected by the scientific database Scopus by Elsevier. The listed institutions were responsible for more than 80% of the global scientific output during 2005-09.[14] For the comparative purpose of this paper, we will consider only the German, French and British institutions included in the report. Health institutions are excluded from our considerations, as they cannot be clearly classified as belonging either to the university or the non-university sector. Private institutions are also excluded, because they are not part of the public research sector.

[11] Cf. Polt et. al. (2010), p. 53.
[12] Cf. OECD (2012), pp. 69 and 75f.
[13] Cf. Polt et. al. (2010), p. 53.
[14] Cf. SCImago (2011).

When using the SCImago rankings, we have to keep in mind that it ranks the Max Planck Society and the Fraunhofer Society as individual institutions representing the research output of 84 Max Planck institutes and 85 Fraunhofer institutes. Institutes belonging to the Helmholtz Association and the Leibniz Association, by contrast, are listed as single institutions. Therefore only a few Helmholtz and Leibniz institutes are visible on a global scale, whereas Max Planck is able to occupy a top position. Unless the statistical database is changed we have to put up with this bias. Moreover, the report does not differentiate between governmental and other non-university research organizations, instead applying the label governmental to all of these institutions. Again, it would be helpful if the data were adjusted.

Comparing the three countries, we can observe important differences. Overall, the ranking lists 112 German institutions (excluding health and private research institutions). The total number of publications is 591,375. With nearly 50,000 publications, the Max Planck Society has the biggest individual share (8.3%), followed by Ludwig Maximilian University of Munich (3.5%) and the University of Heidelberg (3.4%). When looking at the whole picture, however, higher education institutions clearly outnumber the non-university sector, with cumulative shares of about 78.8% and 21.2%, respectively.

In contrast to Germany, France has a non-university research sector that is much more concentrated, and we find a more balanced distribution between both sectors. The ranking features 110 French HEIs and PROs, which, together, have a publishing record of 426,355. The CNRS is the most important player. As a single gigantic research institution, its share amounts to 130,977, or 30.7%, whereas the share of the other two big institutions, CEA and INRA, adds up to 7.2%. By comparison, the most productive universities in terms of publication output are Paris 6 (4.9%), Paris South (3.2%) and Paris 7 (2.9%). The university-non-university sector ratio is 53.5% to 46.5%.

In the case of Britain, SCImago lists107 institutions producing a total of 593,184 scientific publications. What is striking is the overwhelming dominance of higher education institutions, which together have a share of 95.4%, compared to a meagre 4.6 % for the non-university sector. The five leading universities (University College London, Cambridge, Oxford, Imperial College London and Manchester) together have a share of over one quarter (25.9%). According to these numbers, the British public non-university sector seems to be quite insignificant for the publication output.

University rankings

In international rankings such as the Shanghai and THES rankings, a university's reputation is predominately defined in terms of its research performance. Excellent research, in turn, attracts excellent researchers, increasing the potential for further innovation. When using this measure, the UK enjoys a clear advantage. Only British universities are able to achieve Top 10 positions in both rankings: two in the 2012 Shanghai ranking, and three in the 2012-13 THES ranking. Expanding our view to the Top 50, we see five and seven British universities in the Shanghai and THES rankings, respectively, whereas only two French universities make it into the Shanghai Top 50, and only one German university into THES. To find both German and French universities, we have to look at the Top 100 of both rankings: Shanghai lists four German and three French universities; THES features four German and four French universities, compared to nine and ten British universities, respectively[15] It would be misleading, however, to take the Shanghai or THES rankings as indicators of research quality as such, because countries with a strong non-university sector are systematically misrepresented.

International alignment and citation rate

The category 'international alignment' shows whether a country's researchers publish their work in internationally visible or less visible journals, judged against the world average (0). The comparison between the three countries reveals an advantage for the UK, which in 2007 achieved a value of 25, compared to 21 for Germany and 17 for France. The US value is 34.[16]

The citation rate considers the actual year of publication and the two following years. Self-citations are excluded. It gives an idea of the quality of the published research. In 2007, the citation rates were 5.1 (UK), 4.8 (Germany) and 4.5 (France), compared to 5.5 for the US.[17]

ERC grants

ERC grants serve as an indicator of highest academic excellence, because they are assumed to stimulate high-risk research and indicate the attractiveness of a country for excellent researchers. Between 2007 and 2010,

[15] Cf. Shanghai Ranking Consultancy (2012)/ TSL Education (2012).
[16] Cf. Schmoch et. al. (2011), p. 5.
[17] Cf. ibid., p. 7.

British institutions received about 350 grants, compared to about 240 for France and about 230 for Germany. By including information on researchers' nationality, the grants also illustrate a country's attractiveness for excellent foreign researchers. The UK attracted the largest number of grantees without UK nationality (far over 150), whereas France hosted over 50 excellent foreign researchers. Both countries have a positive balance in terms of hosting non-national grantees and sending their own nationals abroad. Germany, by contrast, has the most negative balance with over 100 German grantees working outside of their home country.[18]

Patent output

Comparing the three countries' patent output (filed under PCT) as a standard indicator of innovation reveals an advantage for Germany, with an absolute number of 17,095 in 2010, compared to 7,111 for France and 5,243 for the UK.[19] That does not mean, however, that the German PROs are above-average contributors to the patent output. To get an idea of their share, we can draw on data collected in 2008, when the German patent output (filed under PCT) stood at about 16,990.[20] The big four non-university organizations (Max Planck, Helmholtz, Leibniz, Fraunhofer) together produced 1,036 patents (excluding double entries) filed under PCT, the EPO and the German Patent and Trade Mark Office in 2008.[21] These figures suggest moderate gains rather than above-average advantages of a highly diversified public non-university research sector.

In sum, we have shown that the UK is top in terms of number of publications, citations, and international visibility. It clearly outperforms Germany and France with regard to both ERC grants and the Shanghai and THES rankings. Although some of the differences can be explained by misleading statistics, we don't see any systematic advantages of the German or French systems with their large non-university research sectors. It is only in terms of patent output that Germany takes a clear lead, also relative to its population. However, this lead can neither solely nor even primarily be attributed to Germany's PROs. More plausibly, it is connected with the huge German industrial sector.

[18] Cf. European Commission (2011), pp. 195-197.
[19] Cf. OECD (2011).
[20] Cf. ibid.
[21] Cf. Fraunhofer ISI et. al. (2012), pp. 48-55.

3. The case of non-university research institutions in Germany[22]

Leaving these quantitative indicators behind, we now take a closer look at the specific German system, as it is marked by a unique degree of diversification. The four big non-university research associations – Max Planck, Fraunhofer, Helmholtz and Leibniz – are its most prominent feature. What justifies the existence of such organizations? Are there any benefits we cannot grasp by considering 'conventional' indicators?

The idea behind the four research associations presupposes specific missions that cannot be accomplished by universities.

The origin of non-university research in Germany lies in the Kaiser Wilhelm Society, founded in 1911 to enable private financing for research and to satisfy the needs of the German industry. After the Second World War, the **Max Planck Society**, as the successor of the Kaiser Wilhelm Society, focused on interdisciplinary, long-term basic research. In 2010, it employed 12,672 R&D staff (in FTE) and had a budget of about €1.5 billion.[23] The federal government and the *Länder* each contribute 50% of the funding. Max Planck research covers a wide range of fields, with an emphasis on natural sciences as well as on social sciences and the humanities. Researchers are free to determine their own research agenda as long as they meet strictly defined scientific criteria. The unique feature of Max Planck is a person-centered research approach called the *Harnack principle*, which includes a sophisticated selection procedure and the establishment of an institute around an distinguished researcher, who enjoys a great deal of freedom in terms of how to use the granted resources.

The **Helmholtz Association** unites several formerly independent centres dedicated to big science. With 25,885 R&D-FTEs and a budget of €3.2 billion, it was the biggest non-university research organization in 2010.[24] In general, 90% of the funding come from the federal government, and10% from the institution's host *Land*. The funding parties are represented in proportion to their share in the Committee of Financing Partners, which determines research policy requirements and identifies research fields. Consequently, the federal government has an important influence on Helmholtz research. The historical origin of the Helmholtz Association lies especially in nuclear research after the Second World War. The original mission of a highly concentrated and hierarchically organized research organization has changed and was replaced in 2001 by a programme-centred approach involving various smaller research fields. Today, the primary

[22] The ministerial research organizations are not considered here.
[23] Cf. Federal Statistical Office Germany (2010), p. 18.
[24] Cf. ibid.

research areas are medicine, natural sciences and engineering. Accordingly, the actual mission has become obsolete for approximately half of the centres, as they do not engage in big science in the traditional sense.

The **Fraunhofer Society** offers applied research upon the request of private enterprises or public institutions. Its focus is product-centred research aimed at practical innovation and marketability. It is therefore an important contact for private economic interests. In 2010, Fraunhofer employed 13,926 R&D staff (FTEs) and had a budget of €1.6 billion.[25] Around 30% of its budget is financed by the federal and *Länder* governments, which contribute 90% and 10% respectively. The other 70% are earned through contract research. As Fraunhofer strongly relies on private funds and mandates of clients, the research conducted is client-oriented. As a consequence, the Fraunhofer Society itself is organised like a corporation, with a central management and quality management based on client surveys. The by far most important field of research is engineering, which reflects Fraunhofer's industry-friendly orientation.

The **Leibniz Association** consists of research institutes, museums, libraries and service institutions. Compared to the other research organizations presented above, it lacks a clearly defined profile. This has to do with its historical origins: Leibniz was not founded as an organization with a specific mission, but as an umbrella organization for already existing, very diverse institutions whose main similarity was that they were funded by the federal and *Länder* governments (typically 50:50). In 2010, Leibniz employed 11,270 R&D FTEs, and its budget added up to €1.2 billion.[26]

How can we evaluate a system like Germany's, with such big non-university research organizations? What special advantages do they offer?

The **Max Planck Society** is focused on basic research. In contrast to the professorial chairs at universities, a director of a Max Planck institute is not confined by disciplinary boundaries. Moreover, in 2006-08, the Max Planck Society achieved the highest publication intensity (1.56 per researcher) among the other three organizations and the universities (SCI-Index; universities: 1.32). [27] Nonetheless, a system dominated by research universities such as the UK's is also able to attract excellent researchers and to achieve an excellent research output, especially if measured in terms of ERC grants, university rankings and the SCImago ranking. There seems to be no compelling argument that the specific mission embodied by Max Planck necessarily has to be fulfilled outside of the universities.

[25] Cf. Federal Statistical Office Germany (2010), p. 18.
[26] Cf. ibid.
[27] Cf. EFI (2012), p. 45.

As stated before, almost half of the institutions of the **Helmholtz Association** do not conduct research in the original sense of big science using heavy equipment. The former nuclear research facilities in Jülich and Karlsruhe, for example, now are committed to smaller research fields like transport, communications and health. On the level of the association as a whole, a clear mission cannot be found anymore. It is a research organization, however, that allows the federal government a high degree of influence on the research agenda.

As indicated above, the **Leibniz Association** offers no internationally exemplary model, as it never had a specific mission as a whole. Recently, however, many institutes have been looking for opportunities to collaborate more closely with the universities. This juncture may be a model for achieving higher visibility in the years to come.

The **Fraunhofer Society** offers a sharp contrast to the research university model. Whereas the latter is shaped by a high degree of autonomy, with researchers determining their own research agenda and responding independently to the needs of society, Fraunhofer is dedicated to fulfilling concrete client orders. The research carried out, therefore, is in the specific interest of corporations, and Fraunhofer participates directly in the transfer of knowledge and technology towards the economy. Accordingly, it embodies a specific research mission that is clearly distinct from the idea of independent university research. In Fraunhofer, corporations have a visible business-friendly research partner for needs that cannot be addressed within the university structure or within the corporations themselves. Therefore, it stimulates innovations that can be transferred directly to the market. Moreover, the Fraunhofer Society is far ahead of the other three associations and the universities in terms of declared patents, with 71 patents per one thousand researchers in 2006-08 (universities: 39; Max Planck: 17; Helmholtz: 31, Leibniz: 23).[28]

In sum, the highly developed and diversified non-university research sector in Germany cannot serve as an easily transferable model. Its origin lies in special historical circumstances, and it is shaped by political federalism. Consequently, the creation of this sector is strongly connected to the constitutional restrictions that keep the federal government from funding the universities directly, a fact that strengthened the development of a non-university research sector, independently of the notion of research missions.[29] Moreover, the idea of mission-based research associations that fulfil tasks that cannot be addressed adequately within universities has its

[28] Cf. EFI (2012), p.45
[29] Cf. EFI (2011), pp. 26-41.

limits in the German case. The Leibniz Association does not have a clear identifiable mission as a whole. The Helmholtz Association has abandoned its original task of conducting big science and substituted it by a programme-based approach. Here, the federal government has the best possibilities to exert a major influence on research contents. That, however, makes it difficult to draw a clear line between Helmholtz research and ministerial research. The goal of the Max Planck Society to offer long-term, interdisciplinary basic research led by outstanding researchers with a high academic reputation does not necessarily imply a non-university setting, since research universities are fully able to perform that way, as in case of the British system. The Fraunhofer Society, by contrast, offers a mission that should not be merged with the concept of a research university. Fraunhofer offers research commissioned by clients, mostly private enterprises and public organizations. It therefore represents an important link in the innovation chain, but has grown to become that link since the late 1960s.

3. Conclusion

The analysis of national public research systems of Germany, France and the UK has revealed important differences. All three systems differ with regard to their institutional composition. Whereas the UK has a rather small public non-university research sector, Germany and France have much bigger ones. But the German system seems to be more diversified compared to the French, which is shaped by big single institutions. It has become clear that important specific historical and institutional factors exist that shape the various national public research systems. These factors are hard to overcome, especially in a multi-level governance system such as the EU or the ERA. The ERA, therefore, is characterized by a high degree of diversity in terms of national public research systems.

To foster innovation, it is important to review and develop indicators of public research performance. The existing indicators hint mainly at the commercialization aspects of innovation and fail to recognize the numerous aspects of knowledge exchange with society and the economy as a whole. In particular, the role of universities as drivers of innovation in the service economy has hardly been studied.[30]

In light of these findings, our conclusion has to concentrate on two issues: First, how can Europe benefit from the diversity of its institutional research arrangements in order to improve the performance of the research system?

[30] The work of Alan Hughes could serve as a starting point for such studies, even though it is only focused on UK universities. Cf. Hughes/ Kitson (2012).

Second, how can the European Commission's portfolio of research and innovation indicators be expanded and/or specified to represent a more holistic or comprehensive conception of knowledge exchange and innovation?

Regarding the performance of the research system, we can conclude that the UK performs much better than other European countries in terms of academic excellence, as expressed in international university rankings, most importantly the Shanghai and THES rankings. Nonetheless, Germany is classified as an innovation leader, as measured by the composite indicator of the European Commission's Innovation Union Scoreboard, whereas the UK, like France, is classified as an innovation follower. The UK might perform very well with regard to the international reputation of some of its universities, above all Oxford and Cambridge; however, it lags behind – especially when compared to Germany – in terms of PCT patent applications, community trademarks and community designs.[31]

For the abovementioned reasons, it does not seem appropriate for the UK to restructure its excellent universities, nor would it make sense for Germany to abolish the Fraunhofer Society, which performs very well in terms of PCT patents. Before simply copying structures, necessary background conditions have to be met. The success of Fraunhofer, for example, is closely connected to the existence of a huge industrial sector, which is not the case in the UK. Models for research institutions, therefore, cannot be seen in isolation from their context.

In the long run, institutional learning might occur between different national systems in the ERA if a pertinent monitoring system were to be established, based on regular reporting and featuring comparable indicators and intensive information exchange activities. If the ERA and the Innovation Union are to improve their performance, it is advisable to strengthen the successful institutions of different systems instead of creating a similar institutional set-up all over Europe. A step towards identifying institutional features and institutional performance is currently underway with U-Multirank and the Global Research Benchmarking System (GBRS). GRBS offers an in-depth analysis on the research performance of Higher Education Institutions that helps identify niche strengths not reflected in the common university rankings.[32] U-Multirank is a monitoring tool designed for conducting an analysis of institutional performance and political strengths and weaknesses. The basic logic is achieving transparency of horizontal diversity. In this context, world-class research is conceived as just one profile among others relevant to innovation and society. The tool contains six dimensions: teaching and learning, research involvement, knowledge exchange, international orientation, regional

[31] Cf. European Commission (2012), pp. 29, 35 a. 51.
[32] Cf. http://www.researchbenchmarking.org/web/guest/home.

engagement and student profile. In contrast to the common international university rankings, U-Multirank does not provide a composite indicator and a general ranking of such diverse institutions.[33] Both tools are, however, restricted to higher education institutions. It would be beneficial to have similar tools available for assessing PROs with regard to academic excellence and different dimensions of innovation.

Regarding adequate performance indicators for innovation, it should be emphasized that knowledge exchange activities among academics do not primarily aim at product commercialization. Academic activities besides university teaching include giving guest lectures, attending conferences or participating in networks. Moreover, providing informal advice or consulting services is far more common than the commercialization of products. In a minority of cases, businesses seek the support of universities (at least in the UK) for product innovation, but they do it much more often with regard to marketing and sales.[34] Innovation indicators should also reflect this dimension of innovation.

4. Recommendations

- **Support successful institutions in national research systems.**

ERA is regarded as a European public research system consisting of different national systems that have evolved historically and encompass a wide range of universities and non-university research institutions. ERA aims at improving the performance of the research system in terms of academic excellence and of innovation. Therefore, we recommend strengthening the successful institutions in each national system instead of creating similar institutional set-ups all over Europe.

- **Strengthen research universities.**

The UK research system performs best with regard to international visibility, publication output, citation rates and ERC grants. This successful model is based on outstanding, research-intensive universities and should be strengthened. If appropriate, it can provide essential inspiration for other HEIs within the ERA. It has to be emphasized that for several reasons research

[33] Cf. van Vugh/ Ziegele (2011).
[34] Cf. Hughes/ Kitson (2012), pp. 726f.

universities are the centrepieces of any research system, as they combine research with the education of future scholars.

- **Create or maintain only those PROs that fulfil a mission that cannot be accomplished at a research university.**

PROs should not weaken the capabilities of universities. Therefore they should possess a distinct mission, which cannot be accomplished at a research university.

This is the case when research organizations have to conduct research directly for the needs of the government, other public institutions or private enterprises. In contrast to a research university, the PRO research agenda should be determined largely by its sponsors or clients and correspond directly to their concrete needs. Moreover, there has to be a compelling reason why this mission has to be accomplished within a public institution. The Fraunhofer Society, for example, offers an application-oriented R&D infrastructure based on contracts. Thus it offers customized scientific support to small and medium-sized enterprises as well as other public/private institutions that are not able to conduct R&D themselves. Consequently, Fraunhofer represents an innovation-friendly model, because of its focus on engineering, particularly for product innovation, which cannot be achieved by a research university.

Enhance cooperation between universities and non-university institutions where appropriate.

Even though each institution should have a distinct mission, the channels between universities and PROs should not be closed. The cooperation between universities and non-university institutions can lead to synergy effects if research interests are combined and geographical proximity is given.

- **Set up a European-wide monitoring system for all single public research institutions.**

To achieve better comparability, we recommend establishing a common monitoring system for public European research institutions, including a complete list of European universities and non-university organizations. It

would be most important for such a European monitoring system to avoid the bias represented in existing rankings, which tend to distort the situation by showing a preference for large, established institutions and for science and medicine, by not considering niche strengths of institutions, and by using only a single source of bibliometric data.

Use the newly developed tools of GBRS and U-Multirank.

The Global Benchmarking Research System (GBRS) provides flexible analytical tools, which permit the user to focus on specific aspects of a university's research performance and therefore allows for identifying niche strengths. U-Multirank offers a multidimensional assessment of higher education institutions. Six categories are covered, each made up of several indicators. The categories are: education profile, student profile, research involvement, knowledge transfer, international orientation and regional engagement. It is not designed as a ranking, but allows users to rank universities according to their individual criteria, thus making U-Multirank a highly flexible tool.

Integrate non-university public research institutions in the monitoring as well.

Most of the existing monitoring tools, including GBRS and U-Multirank, do not cover public non-university research institutions. As shown above for the cases of Germany and France, the non-university sector can play an important role in a research system. Thus the integration of PROs should also be a primary concern when designing a European-wide monitoring system. As a first step, it would be necessary to identify all of the PROs in the EU/ERA, because the 150 institutions identified so far only represent a small share of the total. When including PROs in the system, some performance indicators (e.g. in U-Multirank) would have to be adapted whereas others inappropriate for PROs (e.g. student profile) would have to be excluded.

Develop indicators of knowledge exchange for public research institutions that also reflect the importance of low-threshold exchange and marketing activities.

Conventional indicators ignore some very important features of the knowledge exchange between public research institutions and private or public partners. A survey in the UK revealed some underestimated aspects in this context. Firstly, the channels for knowledge exchange are broad. Informal contacts, guest lectures or the attendance of conferences are more common than licensing and patenting. Scholars mention a lack of time and university bureaucracy as main obstacles for knowledge exchange activities. Consequently, an indicator should

be developed that not only measures the time devoted to research but also the time devoted to low-threshold knowledge exchange activities, for example through conferences with business representatives or civil society actors. Secondly, especially in the case of the social sciences, marketing activities and human resource management are main fields of interaction between businesses and universities. An indicator should be developed that reflects these activities and gives the social sciences a more realistic representation in the monitoring process.

- **Adapt the Shanghai, THES and SCImago rankings or associate PRO research performance with that of the universities.**

Although the Shanghai and THES rankings are biased for the abovementioned reasons, they nonetheless remain internationally influential, especially in terms of research reputation. We therefore recommend adapting these rankings in a way to make them display the real research performance also of countries with an important non-university research sector, such as France or Germany. If that is not possible, adapt the national systems in a way that non-university research performance can in some way be associated with that of the universities and thus show up in the rankings.

At this point, the existing tools for directly comparing university and non-university institutions are either missing or very biased. In the case of the SCImago ranking, it would be a necessary improvement to organize non-university umbrella organizations in a way that they can appear as a whole in the report. A new European-wide monitoring tool should follow this suggestion as well.

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