International Comparative Performance of the Czech Republic Research Base 2012

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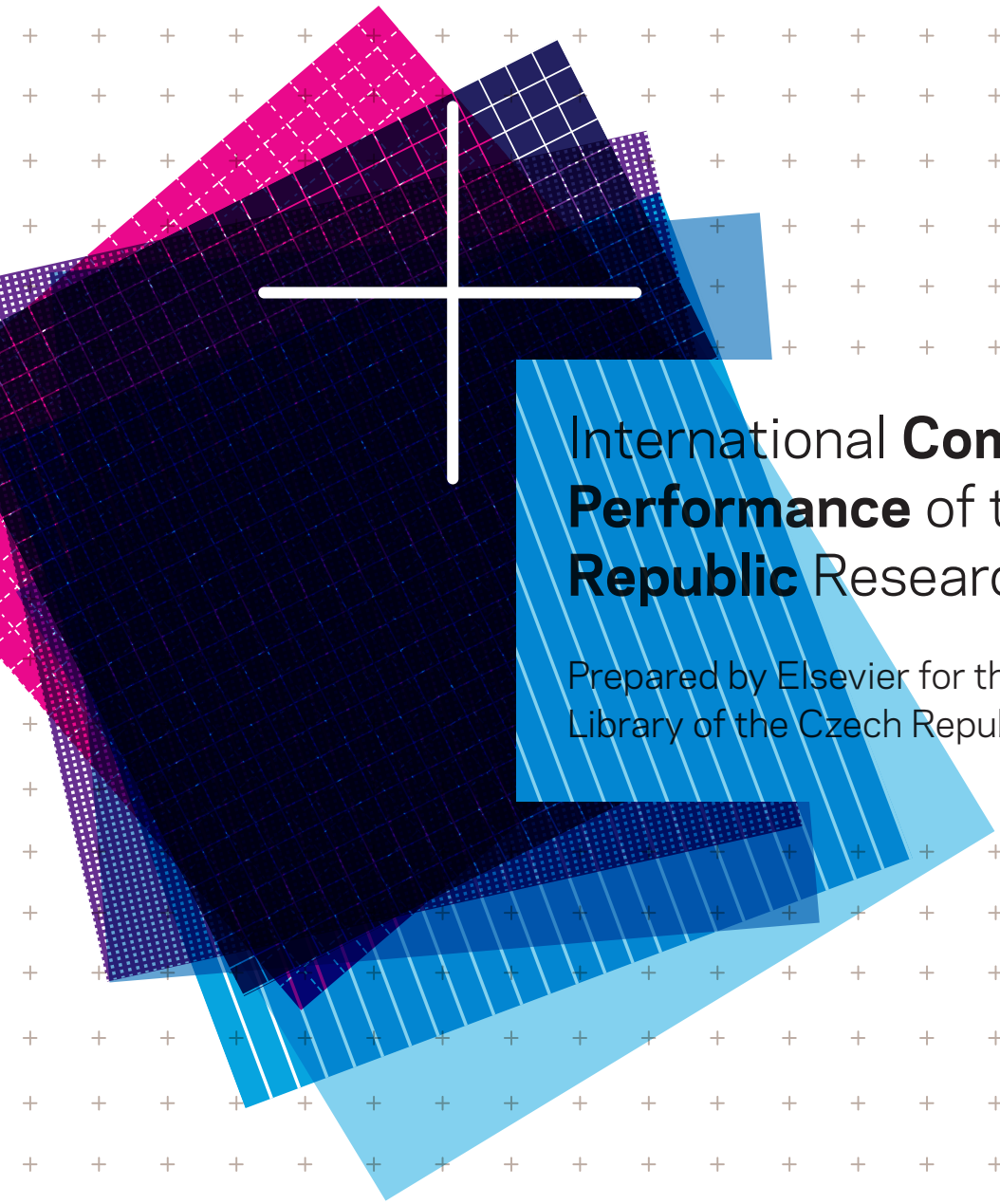

International **Comparative Performance** of the **Czech Republic** Research base **2012**

Prepared by Elsevier for the National Technical Library of the Czech Republic in October 2012

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Executive summary International **Comparative Performance** of the **Czech Republic** Research base **2012**

This report has been commissioned by the National Technical Library of the Czech Republic to assess the performance of the Czech Republic research base compared with selected comparator countries (Austria, Belgium, Germany, France, Finland, Hungary, the Netherlands, Poland, the Slovak Republic, Switzerland, Sweden and the United Kingdom) and world, EU27 benchmarks for the period 2002-2011.

The Czech Republic's scientific research base has shown many signs of positive development in the last decade. Czech output has grown 10% per year which is fastest of the comparator countries examined in this report, and faster than the world growth rate of 5.8% per year. The Czech Republic has thereby increased its share of the world's scientific research output from 0.5% in 2002 to 0.7% in 2011 producing almost 15,000 articles in 2011.

Relative to the world overall, the Czech Republic shows high levels of activity in Agricultural and Biological Sciences, Chemistry, Earth and Planetary Sciences, Mathematics and Physics and Astronomy while showing less activity in Arts and Humanities, Dentistry, Energy, Engineering, Nursing, Psychology, and Social Sciences. Particular areas of growth since 2002 have been Computer science, Engineering, Mathematics and Social Science.

The Czech Republic's field weighted citation impact — an indicator of research quality that adjusts for differing citation practices in different subject areas — has increased from below world average level (0.76) in 2002 to above world average (1.14) in 2011. This indicates significant gains in the quality of research.

Notably, we see that Czech field weighted citation impact in Mathematics is 1.6 times world level, which is remarkable, as this is an area of particular focus representing over 10% of Czech output in 2011 and having grown 18.8% per year since 2002. We also see that Czech field weighted citation impact in Physics and Astronomy, which represents 17% of Czech Science in 2011, has risen from below world level (0.87) in 2002 to above world level (1.27) by 2011. Biochemistry, Genetics and Molecular Biology, Computer Science, Chemistry, Materials Science, which each represent between 11% and 13% of Czech output, all show above world average field weighted citation impact.

In 2011, 37% of Czech authored articles were co-authored with a non-Czech researcher. While this is a higher level of international collaboration than Poland (29.1%), all remaining comparator countries show international collaboration levels of over 40% in 2011. Czech levels of international collaboration have been relatively stable in the last decade, fluctuating between 37% and 40%. Similarly, Hungary, Poland and the Slovak Republic have also not shown increases in international collaboration, which is in contrast to the remaining (and mostly Western European) comparator countries which do show increases in international collaboration.

Looking at the research collaboration of the 13 countries examined in this report, in most cases there is a clear citation advantage that accumulates to internationally co-authored papers, over and above that of nationally co-authored or single authored articles. The Czech Republic's nationally collaborated papers were, on average, cited just as often as their single author papers, while internationally collaborated papers were cited 2.6 times as often — thereby demonstrating the significant contribution that

international collaboration can make towards the overall citation impact of a country.

Examining the relationship between levels of international collaboration and field weighted citation impact, between countries in 2011, reveals a significantly positive correlation of .8 indicating a positive statistical relationship between international collaboration and citation impact. Countries which engage in a higher percentage of international collaboration tend to have higher citation impact than countries which engage less in international collaboration. This is in-line with other studies which also found that internationally co-authored articles, on average, receive more citations than non-international collaborated articles.

In 2011 the Czech Republic collaborated most with the United States (1278 co-publications with a field weighted citation impact of 3.18), followed by Germany (1268 co-publications with a field weighted citation impact of 3.11); the UK (930 co-publications with a field weighted citation impact of 4.09); France (910 co-publications with a field weighted citation impact of 3.37) and Italy (643 co-publications with a field weighted citation impact of 3.43). This again demonstrates the high citation impact that international collaboration can achieve.

Looking at full-text article downloads from ScienceDirect provides an interesting addition to traditional metrics. In 2002 the Czech Republic received 0.4% of world downloads and this share rose to 0.6% in 2011. This is similar to the observed level of Czech citations received which rose from 0.4% in 2002 to 0.7% in 2011. The Czech Republic's *relative download impact* was 0.72 in 2002, indicating that Czech publications were downloaded 72% of the world average number of downloads per paper. By 2011 Czech download impact has risen to 0.88 indicating that publications were downloaded 88% of the world average number of downloads per paper – which is still below the world average. The exact meaning of full-text article downloads, and the possible relationship between article downloads and future citation, is still being investigated.

The Czech Academy of Sciences (CAS), which represents a group of institutions, produced the largest volume of publication output, having published 3885 articles in 2011 (representing 26.2% of the Czech Republic's total publication output). CAS also demonstrates the highest levels of international collaboration (53.8% in 2011). CAS' overall field weighted citation impact has been above world average since 2002 and shows an increasing trend representing improvements of overall quality of research in the last decade. Given the large share of Czech science which CAS research represents, this can be seen as a significant contribution towards the overall increases in citation impact we observe for the Czech Republic.

Key findings

OUTPUT

10% growth per year since 2002

GLOBAL SHARE

0.7% with 14,823 articles in 2011

CITATION IMPACT

Above world average at 1.14

CO-AUTHORSHIP

37% with non-Czech researchers

TOP COLLABORATORS

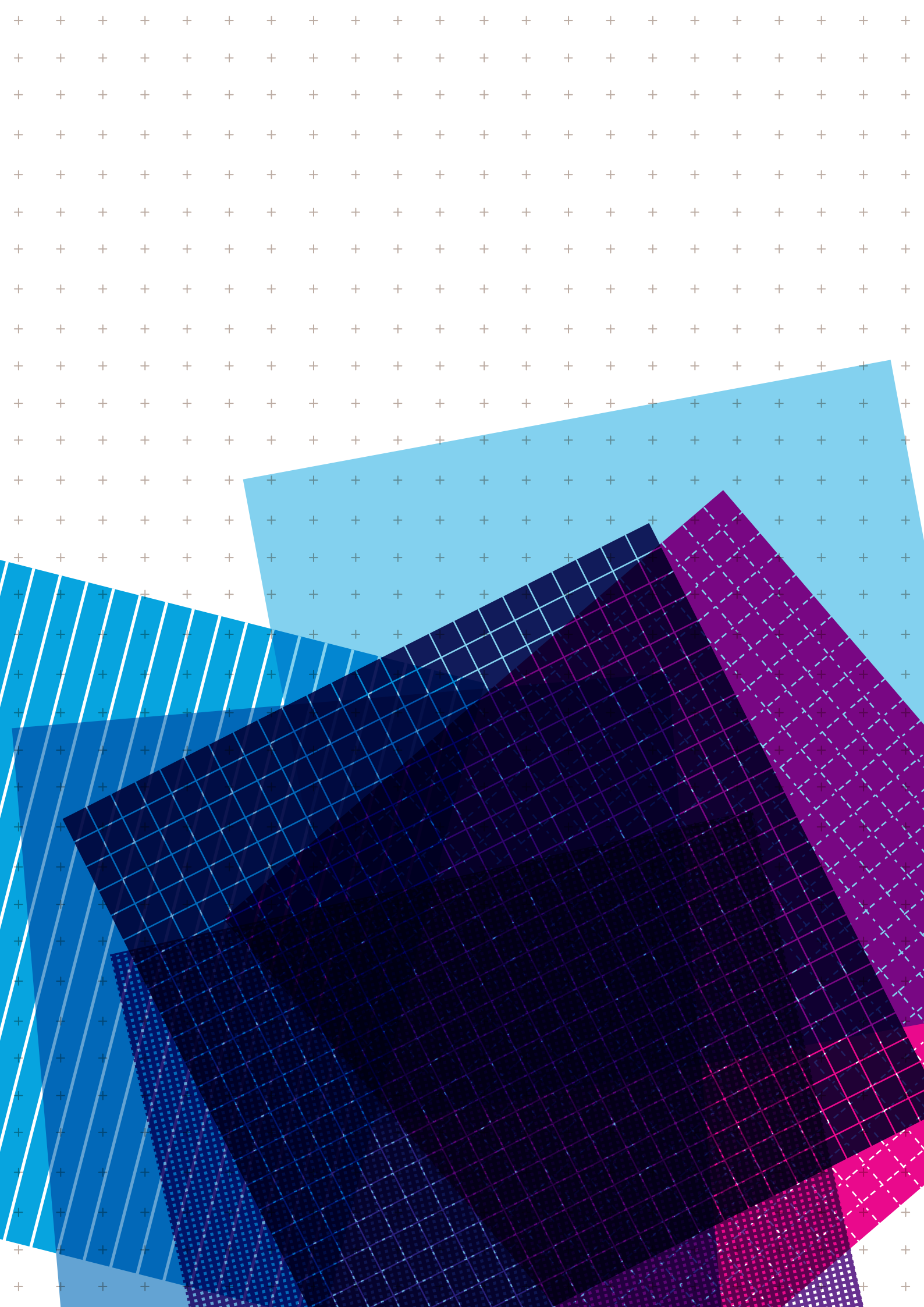
US, Germany, UK, France, and Italy

DOWNLOAD IMPACT

Below world average at 0.88

TOP INSTITUTION

Czech Academy of Sciences (CAS)



Contents

Introduction

This report has been commissioned by the National Technical Library of the Czech Republic to assess the performance of the Czech Republic research base compared with selected comparator countries (Austria, Belgium, Germany, France, Finland, Hungary, the Netherlands, Poland, the Slovak Republic, Switzerland, Sweden and the United Kingdom) and world, EU27 benchmarks for the period 2002-2011.

The key findings and insights discussed in this report are data-driven and based on bibliometric analysis of the relevant bodies of publication data. Our methodology is founded upon the theoretical principles and best practices developed in the field of quantitative science and technology studies, particularly in science and technology indicators research. The analyses of bibliometric data in this report are based upon recognised advanced indicators (e.g., the concept of relative citation impact rates). In the past decade, the field of indicators research has developed a best practice as to how indicator results should be interpreted and which influencing factors should be taken into account. With our methodology we build further on these practices. Please refer to the appendix of this report for more details on our methodology and data sources.

The cited article by *Nature* suggests the Eastern European countries lag behind Western European countries in terms of their scientific output, but that they are catching up. A report prepared for the European Commission positions the Czech Republic as a transitional country showing positive signs of development towards a knowledge economy [1]. Our report provides an analysis of the progress that Czech Science has made in the last decade. We focus on the overall quantity and quality of research, and growth thereof, international collaboration and its relationship with citation impact, as well as providing a look into full-text article download statistics and identifying the Czech institutions which produce the highest volumes of scientific publications.

[1] http://ec.europa.eu/invest-in-research/pdf/ download_en/ kfg_report_no5.pdf

"Twenty years after the end of Soviet Communist, many of the former satellite states in central and Eastern Europe have joined the European Union (EU). Yet, by many measures the science being done in those states still lags behind. Not only do their overall public and private scientific expenditures tend to be lower than those of their EU partners, as are their levels of participation in EU-funded research collaborations… countries including Hungary, Slovenia, the Czech Republic and Poland have seen the emergence of excellent research groups and institutes, many of them led by scientists who graduated around 1989 and were quick to grasp the opportunity to leave and gather experience abroad… Globally, science has benefited greatly from the flow of talent from Eastern Europe and Russia over the past 20 years. That brain drain has not made the transition at home any easier.… Although it has taken more time than anticipated to put central and Eastern Europe back on the global map of science, the upcoming generation of young, energetic students and scientists should be able to complete the process. It would be to everybody's gain. The heart of Europe deserves good science, but the rest of the world needs good science from this culturally rich region just as much".

Nature 461, 569 (1 October 2009) | doi:10.1038/461569a; Published online 30 September 2009

Chapter 1
Czech Republic's Bibliometric Fingerprint

This chapter presents a bibliometric profile of the Czech Republic, which has been termed a bibliometric fingerprint. We look at the overall quantity, quality and growth of publications; benchmarking the Czech Republic's scientific performance against selected countries and the world and EU27.

1.1 Key Findings

ARTICLES

14,823

The Czech Republic published a total of 14,823 articles in 2011.

COMPOUND ANNUAL GROWTH RATE

10%

Czech publication output has increased 10% per year since 2002 compared to the world average growth of 5.8% per year. As a result Czech article share globally increased from 0.5% in 2002 to 0.7% in 2011.

RELATIVE ACTIVITY

Agricultural and Biological Sciences, Chemistry, Earth and Planetary Sciences

Relative to world levels, the Czech Republic shows high levels of activity in Agricultural and Biological Sciences, Chemistry, Earth and Planetary Sciences, Mathematics and Physics and Astronomy while showing lower relative levels of activity in Arts and Humanities, Dentistry, Energy, Engineering, Nursing, Psychology, and Social Sciences.

INCREASED RELATIVE ACTIVITY

Computer Science, Engineering, Mathematics and Social Sciences

Relative to world levels, the Czech Republic shows increased levels of activity in Computer Science, Engineering, Mathematics and Social Sciences; and decreases in Immunology and Microbiology and Veterinary Sciences.

CITATION IMPACT

1.14

Czech field weighted citation impact – a key measure of quality of research – has significantly increased from being below world average (0.76) in 2002 to above average (1.14) in 2011.

CITATION IMPACT

Above the Slovak Republic and Poland; below Hungary, Germany and Austria

The Czech Republic demonstrates higher field weighted citation impact than the Slovak Republic and Poland. Hungary has achieved a higher citation impact than the Czech Republic. Switzerland, the Netherlands and Belgium all show a field weighted citation impact of over 1.8, while Austria, Sweden, the UK, Finland, Germany and France all show a field weighted citation impact above 1.4. EU27 as a whole shows above world average and increasing field weighted citation impact, as do all the Western European countries examined in this study.

HIGH VOLUME & HIGH IMPACT

Engineering, Physics, Astronomy, Medicine

Engineering, Physics and Astronomy and Medicine are subject areas in which the Czech Republic shows both high levels of output and citation impact. Engineering and Physics and Astronomy each represent more than 15% of Czech output in 2011 and demonstrate an above world level of field weighted citation impact. Medicine is a large subject area (22.6% of the Czech Republic's output in 2011) which shows a positive citation impact of 1.2 times world level. In addition to these high output and impact subjects the Czech Republic shows above average citation impact (2011) in Biochemistry, Genetics and Molecular Biology, Computer Science, Chemistry and Materials Science. Each of these subject areas represent between 11% and 13% of Czech publication output.

KEY AREAS

Mathematics

Mathematics stands out in several respects. The Czech Republic has achieved a field weighted citation impact of 1.6 in Mathematics, which is significantly above world levels. Mathematics is also an area of high activity representing over 10% of Czech output in 2011 and having grown 18.8% per year since 2002.

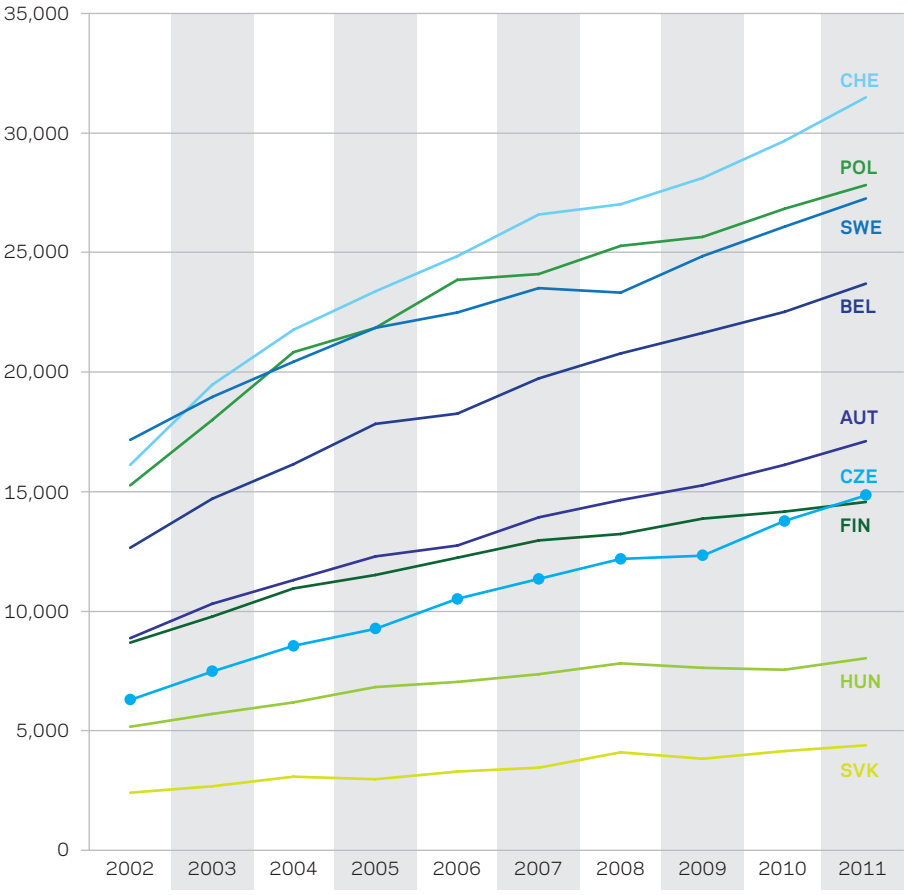
1.2 Publication output: article counts, and growth

The Czech Republic has grown from producing 6,292 publications in 2002 to producing 14,823 publications in 2011. This represents a compound annual growth rate of 10% per year which is the fastest rate of growth of the countries examined in this study. It is also faster than the annual growth rate of overall world scientific output (5.8%) and EU27 (5.7%) for the same period. It should be noted that publication output and growth has been calculated based on relevant publication information in the Scopus database. Interpretation of these figures should take into account that new journals are added to Scopus each year and this may impact the reported growth rates [2].

Czech publication output is growing faster than the world and EU27 publication output. To put this in context: the Czech Republic produced 0.5% of the entire world's scientific publication output in 2002 (and 1.7% of EU27) and by 2011 this has risen to 0.7% of world output (2.4% of EU27). In terms of yearly volume of articles, the Czech Republic produced more publications in 2011 than Finland, Hungary, and the Slovak Republic, while producing less volume of articles than the remaining comparator countries.

In order to classify publications as being related to specific subject areas, we have used a journal based classification system. This means that journals are assigned subject areas, and each publications receives the same subject classification as has been assigned to the journal it is published in. It is good to realise that journals are often assigned more than one subject area, and as such any given article often is classified as belonging to several subject areas. In the methodology we used in this report, we 'whole count' each article towards

Figure 1.1 — *Publication counts per year and Growth as represented by Compound Annual Growth Rate (CAGR) 2002-2011 for the World, EU27, Czech Republic and selected comparator countries. The 4 most productive countries are not displayed on the chart.*



	2002	2011	CAGR
*WLD	1,263,898	2,107,731	5.8%
*E27	379,665	627,614	5.7%
GBR	83,069	133,278	5.4%
DEU	78,460	126,233	5.4%
FRA	57,202	91,470	5.4%
NLD	23,133	42,820	7.1%
CHE	16,111	31,503	7.7%
POL	15,251	27,835	6.9%
SWE	17,156	27,254	5.3%
BEL	12,652	23,688	7.2%
AUT	8,873	17,119	7.6%
CZE	6,292	14,823	10.0%
FIN	8,686	14,573	5.9%
HUN	5,159	8,025	5.0%
SVK	2,397	4,389	7.0%

Table 1.2 — *The percentage total world publications, and percentage of total Czech Republic's Publications, which each subject area represents in 2002, 2006 and 2011, and Czech Compound Annual Growth Rate of each subject 2002-2011.*

	Share World Pubs			Share CZE Pubs			Share CZE Pubs
	2002	2006	2011	2002	2006	2011	2002 – 2011
**All subjects combined*	100%	100%	100%	100%	100%	100%	10.0%
Agricultural and Biological Sciences	6.9%	6.9%	7.8%	10.3%	9.9%	12.3%	12.2%
Arts and Humanities	3.8%	3.4%	3.2%	0.8%	1.0%	1.5%	17.8%
Biochemistry, Genetics and Molecular Biology	12.0%	12.3%	11.9%	13.2%	13.2%	12.7%	9.5%
Business, Management and Accounting	1.7%	2.1%	2.4%	0.6%	0.4%	0.9%	14.8%
Chemical Engineering	4.1%	4.3%	4.4%	3.6%	5.5%	3.7%	10.3%
Chemistry	7.7%	7.1%	9.2%	12.9%	10.9%	12.7%	9.8%
Computer Science	4.0%	7.4%	12.9%	3.1%	6.6%	11.9%	27.9%
Decision Sciences	0.5%	0.6%	0.9%	0.3%	0.5%	0.5%	17.0%
Dentistry	0.5%	0.5%	0.5%	0.1%	0.1%	0.2%	19.6%
Earth and Planetary Sciences	4.7%	4.5%	4.3%	5.7%	5.3%	4.9%	8.2%
Economics, Econometrics and Finance	1.0%	1.1%	1.5%	1.2%	0.8%	1.7%	14.5%
Energy	1.8%	1.8%	2.9%	1.1%	1.2%	1.9%	16.8%
Engineering	15.4%	19.2%	21.1%	8.7%	12.3%	15.9%	17.7%
Environmental Science	4.0%	4.1%	4.7%	3.5%	4.7%	4.6%	13.5%
General	0.8%	0.7%	0.8%	0.2%	0.3%	0.2%	7.2%
Health Professions	1.5%	1.4%	1.2%	0.4%	0.5%	1.2%	23.3%
Immunology and Microbiology	3.6%	3.1%	3.0%	4.8%	3.9%	3.1%	4.7%
Materials Science	7.6%	7.7%	10.4%	10.2%	8.4%	11.2%	11.2%
Mathematics	3.4%	5.0%	6.9%	5.1%	6.3%	10.2%	18.8%
Medicine	23.8%	23.6%	25.7%	23.8%	22.4%	22.6%	9.4%
Neuroscience	3.0%	2.7%	2.5%	1.8%	2.3%	1.8%	10.2%
Nursing	1.1%	1.2%	1.5%	0.1%	0.3%	0.4%	26.2%
Pharmacology, Toxicology and Pharmaceutics	3.6%	3.1%	3.5%	2.7%	2.8%	2.8%	10.6%
Physics and Astronomy	11.8%	11.2%	12.5%	16.9%	17.8%	17.0%	10.1%
Psychology	2.6%	2.3%	2.2%	0.5%	0.5%	0.7%	13.6%
Social Sciences	6.5%	6.5%	7.3%	2.1%	2.3%	4.0%	18.2%
Veterinary Science	1.0%	0.9%	0.9%	1.7%	1.6%	1.0%	3.8%

each subject assigned to it. This in effect causes overlap between subject areas, for example many articles in Physics and Astronomy are also in Mathematics. This is why the cumulative percentage of all subjects in Table 1.2 adds up to more than 100%.

Czech overall publication output has grown 10% per year. A number of subjects are growing faster than 10% per year: Agricultural and Biological Sciences (12.2%), Arts and Humanities (17.8%), Computer Science (27.9%), Decision Sciences (17.0%), Dentistry (19.6%), Economics, Econometrics and Finance (14.5%), Energy (16.8%), Engineering (17.7%), Environmental Science (13.5%), Health Professions (23.3%), Materials Science (11.2%), Mathematics (18.8%), Neuroscience (10.2%), Nursing (26.2%), Pharmacology, Toxicology and Pharmaceutics (10.6%), Physics and Astronomy (10.1%), Psychology (13.6%) and Social Sciences (18.2%). Some of these fast growing subjects represent only a small share of the Czech Republic's research, while others are not only growing fast but represent a large share of total research. Mathematics stands out in that it has grown at 18.8% per year to double its share of Czech research output (from 5.1% in 2002 to 10.2% in 2011). Similarly we see that Physics and Astronomy represents 17% of Czech output in 2011.

We further illustrate the *relative activity* of the Czech Republic and selected comparator countries in each subject

[2] It is beyond the scope of this study to examine the effect of adding new journals to Scopus to the reported publication growth rates and to what extent such an effect may differ between countries.

area by constructing the Activity Radar Charts displayed on the following pages. The Activity Radar Charts were created by calculating the share that each subject represents of total world output, and also calculating the share each subject represents of each country's output. We then divided the country share per subject by the world share per subject. The result is that each subject area's share of world output is indexed to a value of 1. This allows each subject's share of country's output to be contrasted against the norm set by the world. Mathematics for example, represents 6.9% of world output and 10.2% of Czech output in 2011. The activity index therefore indicates a value of 1.4 for Mathematics. It indicates that relative to the world overall, the Czech Republic is 40% more active in Mathematics.

Here, we clearly see that relative to a world overall, the Czech Republic shows high levels of activity in Agricultural and Biological Sciences, Chemistry, Earth and Planetary Sciences, Mathematics and Physics and Astronomy while showing relatively low levels of activity in Arts and Humanities, Dentistry, Energy, Engineering, General [3], Nursing, Psychology, and Social Sciences. Looking at the differences between 2002 and 2011 we observe increased activity in Dentistry, Engineering, Environmental Science, and Health Professions, while observing decreases in Chemistry, Earth and Planetary Sciences, Economics, Econometrics and Finance, Immunology and Microbiology, Materials Science and Veterinary Science.

In Figure 1.4 we see that Austria shows high levels of activity in Agriculture and Biological Sciences, Biochemistry Genetics and Molecular Biology, Computer Science, Earth and Planetary Sciences, Economics, Econometrics and Finance, Environmental Science, Health Professions, Immunology and Microbiology, Mathematics, Medicine, Neuroscience and Physics and Astronomy. Austria hereby shows more areas of high activity than the Czech Republic. Looking at the differences between 2002 and 2011 we observe increased activity in Earth and Planetary Sciences, and Economics, Econometrics and Finance, and decreases in Health Professions, and Medicine.

Hungary shows high levels of activity in Agricultural and Biological Sciences, Biochemistry, Genetics and Molecular Bioology, Chemistry, Immunology and Microbiology, Mathamatics, Neuroscience, Pharmacology, Toxicology and Pharmaceutics, and Physics and Astronomy. Hungary shows itself to be much more specialized in some subjects than others. Looking at the differences in activity between 2002 and 2011 we observe increases in activity in several subjects which have so far not been areas of focus for Hungary, such as Economics, Econometrics and Finance, and Environmental Science, while we see clear decreases in activity in Chemistry, Health Professions, Mathematics, and Neuroscience.

[3] General is a category that contains articles from multidisciplinary journals such as *Science* and *Nature*.

Figure 1.3 — *Activity Radar Chart Czech Republic - this chart shows the relative share of total publications which each subject area represents in the Czech Republic indexed against World values. 1 thus represents the world value.*

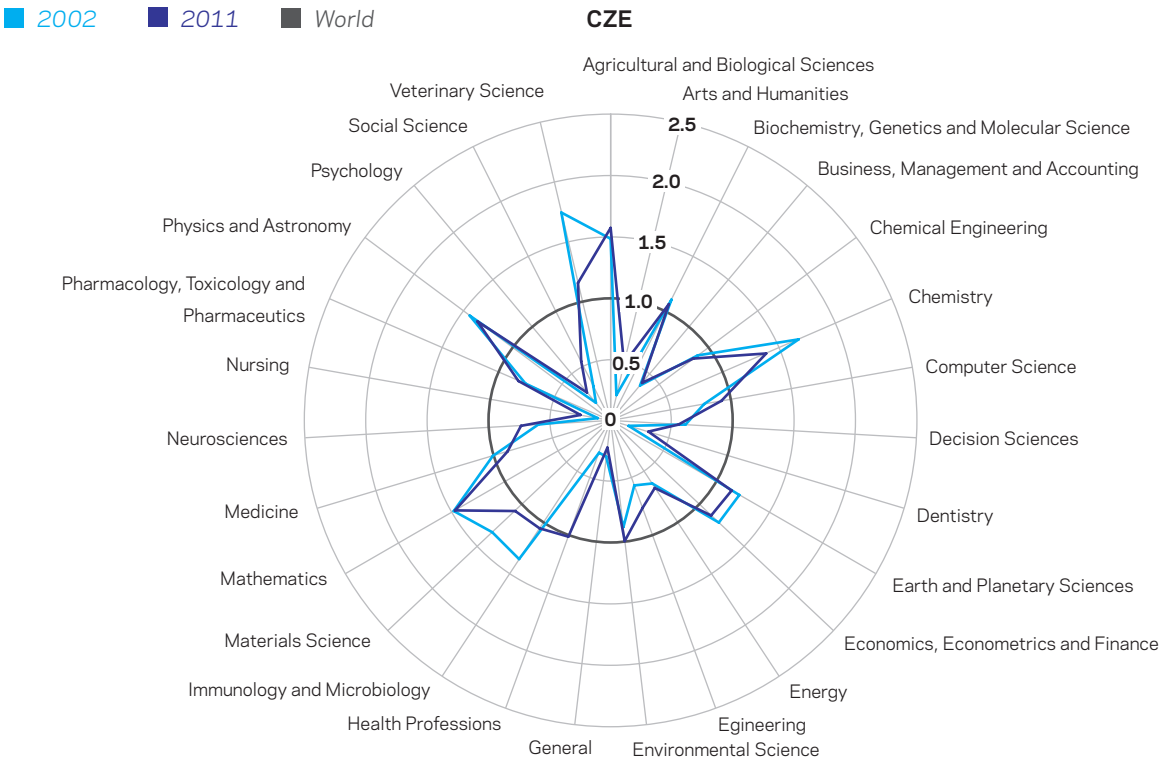


Figure 1.4 — *Activity Radar Chart Austria - this chart shows the relative share of total publications which each subject area represents in Austria indexed against World values. 1 thus represents the world value.*

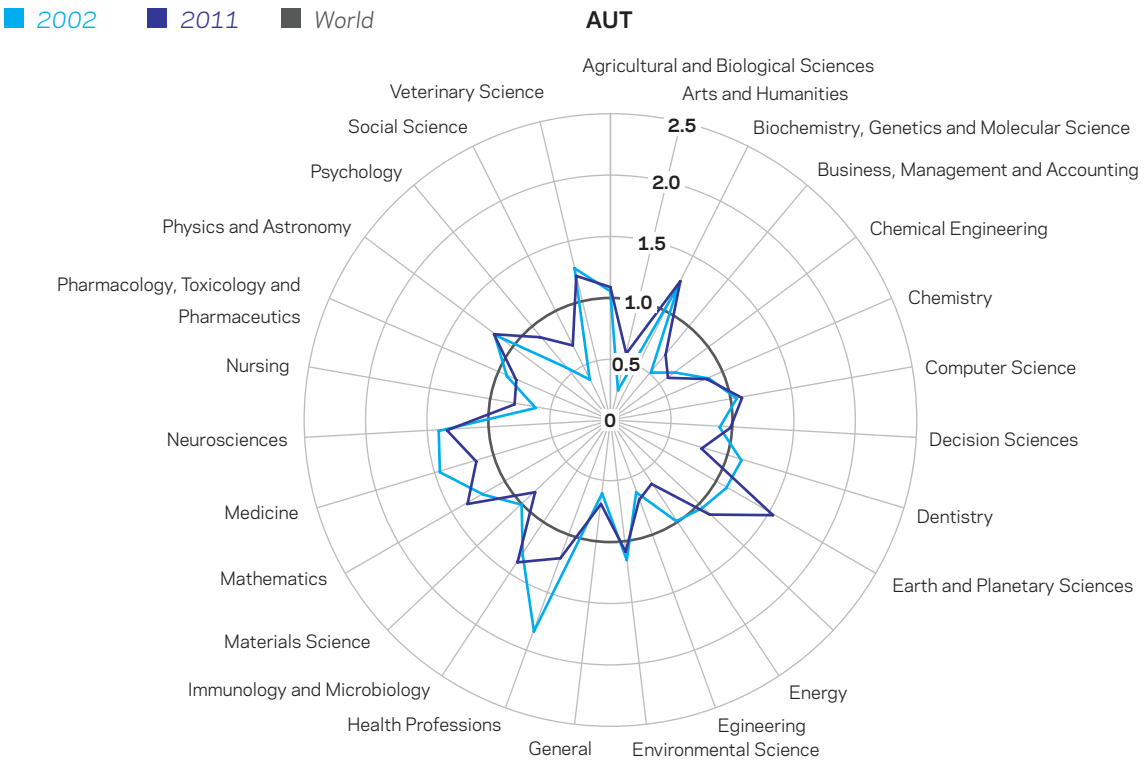
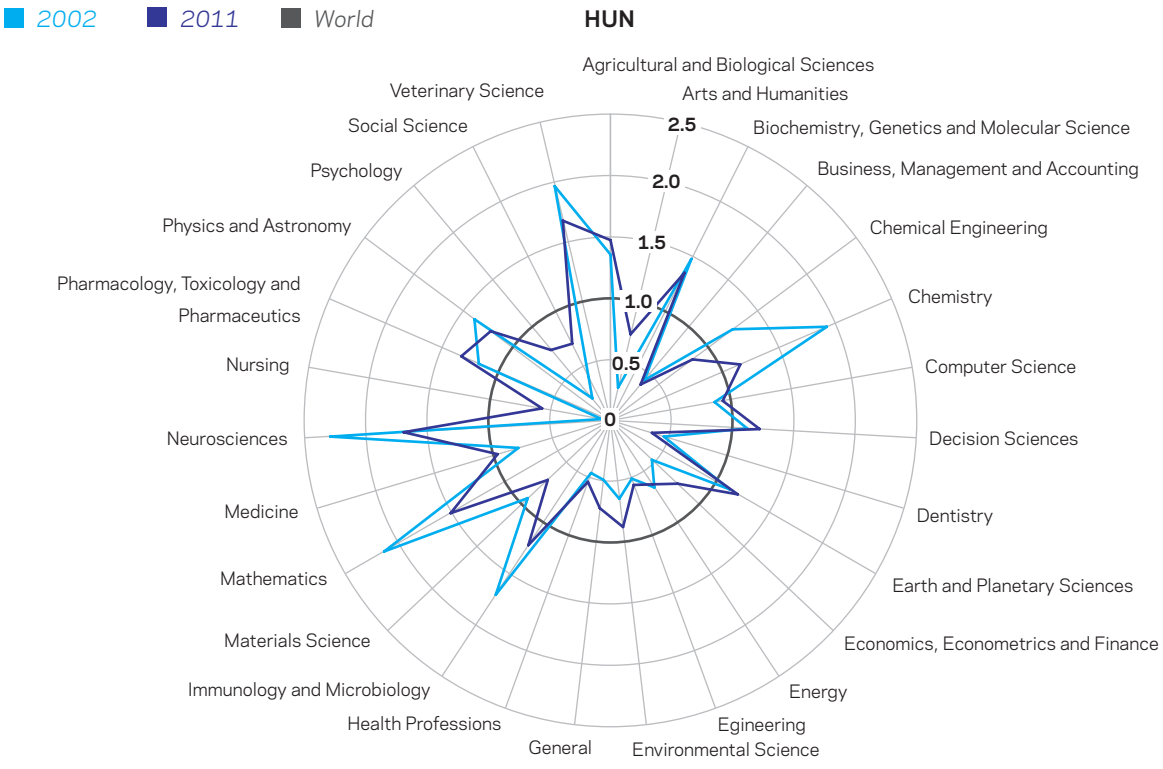


Figure 1.5 — *Activity Radar Chart Hungary - this chart shows the relative share of total publications which each subject area represents in Hungary indexed against World values. 1 thus represents the world value.*



The Netherlands shows high levels of activity in Biochemistry, Genetics and Molecular Biology, Business Management and Accounting, Decision Sciences, Earth and Planetary Sciences. Economics, Econometrics and Finance, Health Professions, Medicine, Neuroscience, Nursing and Psychology. Looking at the differences between 2002 and 2011 we observe increased activity in Business, Management and Accounting, Medicine, Neuroscience, Nursing and Psychology; and decreases in Chemical Engineering, Chemistry, Computer Science, Decision Sciences, Economics, Econometrics and Finnance, Enviromental Science and Pharmacology, Toxicology and Pharmaceutics.

Poland shows high activity in Agricultural and Biological Sciences, Chemical Engineering, Chemistry, Earth and Planetary Sciences, Environmental Science, Materials Science, Mathematics and Physics and Astronomy. This is to some degree a similar pattern to the Czech Republic. Looking at the differences between 2002 and 2011 we see increased activity in Dentistry, Envoronmental Science and Veterinary Science while observing decreases in Chemistry, Materials Science, Mathematics, Pharmacology and Physics and Astronomy.

The Slovak Republic shows high activity in Agrilcuture and Biological Sciences, Chemistry, Earth and Planetary Sciences, Environmental Sciences, Immunology and Microbiology, Mathematics, and Physics and Astronomy. This is to some degree a similar pattern to the Czech Republic. Looking at the differences between 2002 and 2011 we observe increased activity in Chemistry, Earth and Planetary Sciences, Energy, Engineering, and Health Professions, while observing decreases in Agricultural and Biological Sciences, Economics, Econometrics and Finance, Environmental Science, Immunology and Microbiology, Materials Science, Pharmacology, Toxicology and Pharmaceutics, Physics and Astronomy, and Veterinary Sciences.

Interestingly, Poland and the Slovak Republic both show similar patterns of activity to the Czech Republic, while Austria and Hungary show both similarities and differences. The similarities include high activity in Earth and Planetary Sciences, Mathematics, and Physics and Astronomy. Veterinary science is a field in which several countries show decreased activity, including the Czech Republic, Austria, Hungary, and the Slovak Republic, while Poland shows increases in activity in this subject area. The Western European countries show different patterns of activity than the Eastern European countries.

From this section we can conclude that the Czech Republic shows relatively high activity in Agricultural and Biological Sciences, Chemistry, Earth and Planetary Sciences, Mathematics and Physics and Astronomy. This profile is similar to Poland and the Slovak Republic, although volumes of absolute output differ between these nations.

Figure 1.6 — *Activity Radar Chart the Netherlands - this chart shows the relative share of total publications which each subject area represents in the Netherlands indexed against World values. 1 thus represents the world value.*

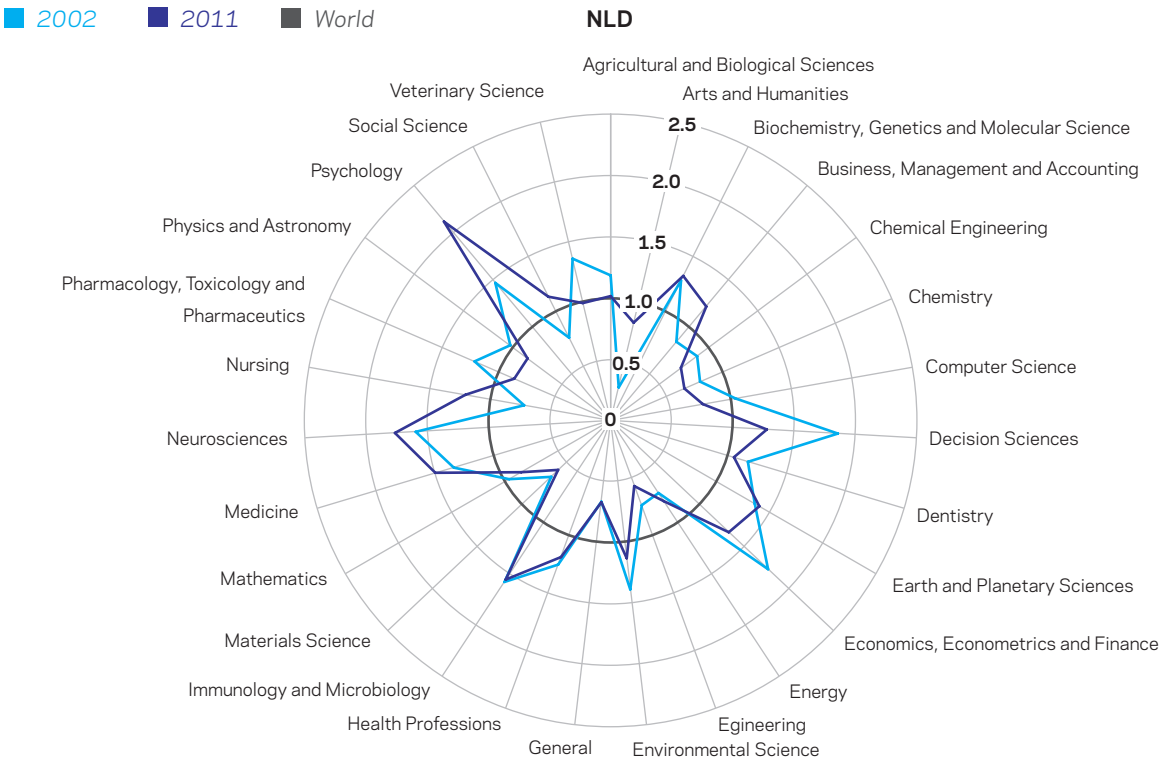


Figure 1.7 — *Activity Radar Chart Poland - this chart shows the relative share of total publications which each subject area represents in Poland indexed against World values. 1 thus represents the world value.*

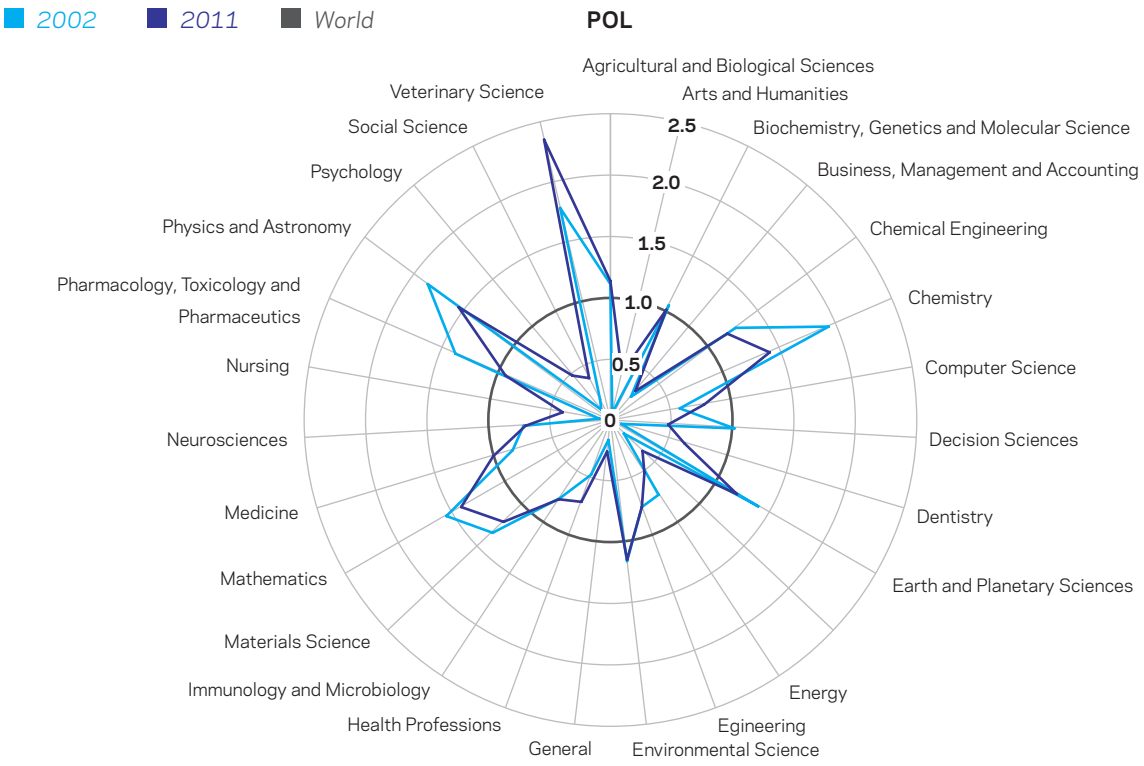
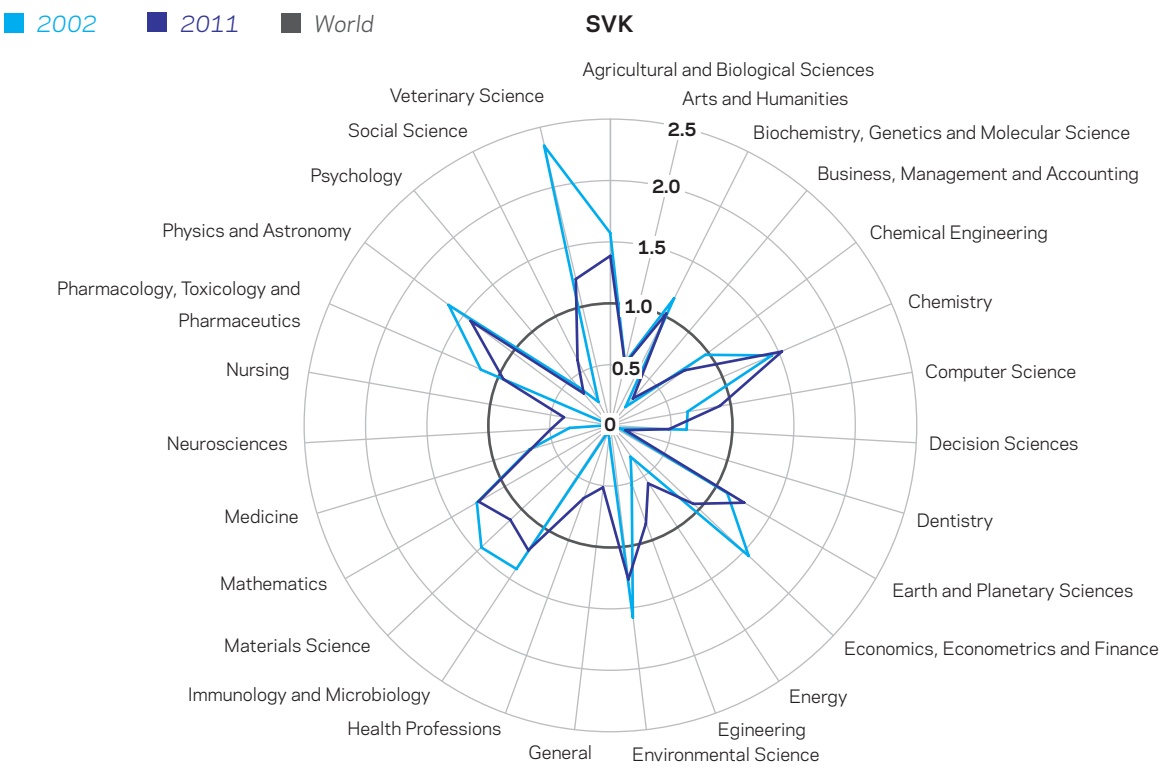


Figure 1.8 — *Activity Radar Chart Slovak Republic - this chart shows the relative share of total publications which each subject area represents in Slovak Republic indexed against World values. 1 thus represents the world value.*



1.3 Citation share and growth

Another crucial dimension to investigate when looking at a country's scientific performance is citations. Citations are typically understood as a measure of quality or importance of scholarly work. Citations accumulate over time, and older publications have more time to accumulate citations. Rather than looking at absolute numbers of citations, it is more insightful to look at the percentage of world citations received, for each country.

In Figure 1.9 (below) we see that the Czech Republic has been receiving an increasing share of world citations, rising from 0.4% in 2002 to 0.7% in 2011. When interpreting citation share, one should keep in mind there that there are differences in citation practice between subject areas. That is to say, some subject areas tend to cite more than others, and as such countries which are relatively active in subjects that cite often, may benefit from this in terms of citation accumulated to their total publication output.

Figure 1.9a — *Share of citations in terms of percentage of total world citations, per year, per country.*

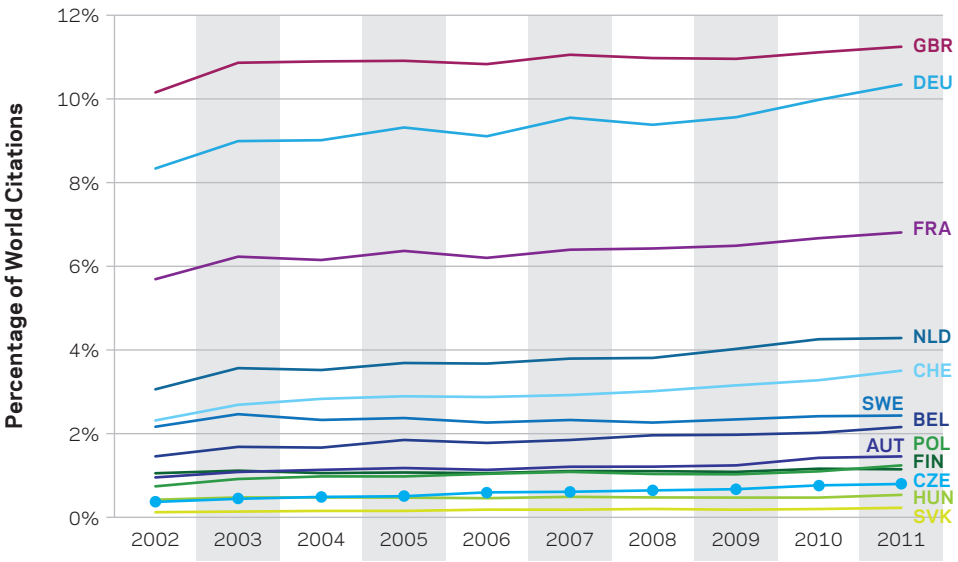
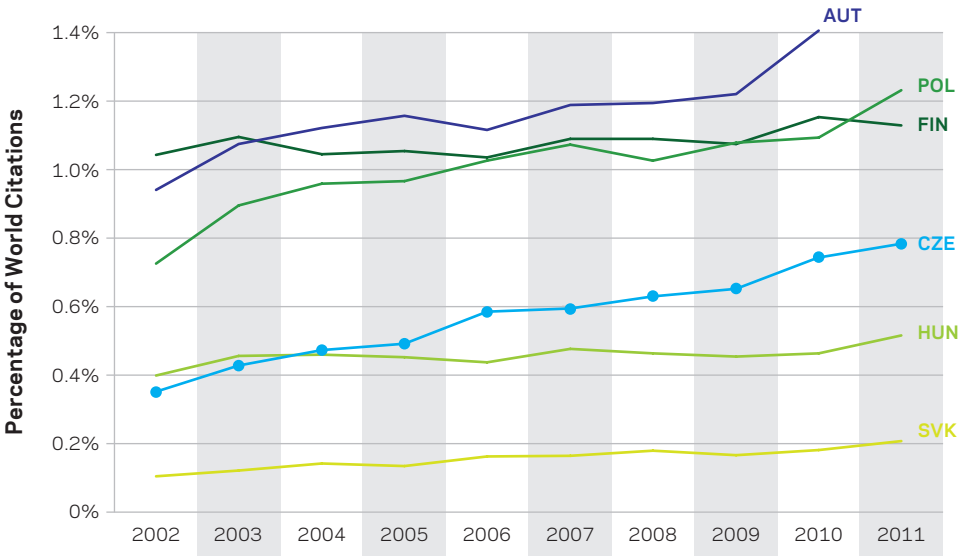


Figure 1.9b — *Zoom of share of citations in terms of percentage of total world citations, per year, per country.*



1.4 Research Impact: Field Weighted Citation Impact

Here we focus on a particular measure of quality of research: Field Weighted Citation Impact. This is a normalized measure of citation impact which compares the level of citations received by a group of papers to world levels and takes into account differences in citation practices between fields. The world is indexed to a value of 1.00 and values above 1.00 indicate above world average citation impact and vice-versa (e.g. a citation impact of 1.80 indicates a citation impact of 1.8 times world level). Field weighted citation impact is a commonly used indicator for quality of research. It provides valuable insight into how much a body of research has been cited in future research, and thereby its 'impact'.

Figure 1.10 (below) illustrates the overall field weighted citation impact of the Czech Republic. We see clearly that the Czech Republic has made significant gains in the last decade: Czech citation impact has risen from under world average level (0.76) in 2002 to above world average level (1.14) in 2011.

When looking at the field weighted citation impact of the comparator countries (in Figure 1.11) we see overall gains in field weighted citation impact during the period. We should note that all the comparator countries are European and that the EU27 as a whole demonstrates a trend of increasing field weighted citation impact, as do all the countries examined in this report.

The Czech Republic demonstrates higher citation impact than the Slovak Republic and Poland. Hungary has achieved a higher citation impact than the Czech Republic, while both countries show a similar rate of increase since 2008. All of the Western European nations consistently perform above the world and EU27 benchmarks. Switzerland has consistently achieved the highest overall citation impact, followed by the Netherlands, and Belgium has made gains to overtake Finland, the United Kingdom and Sweden in terms of citation impact.

Figure 1.10 — *Field Weighted Citation Impact Czech Republic 2002- 2011.*

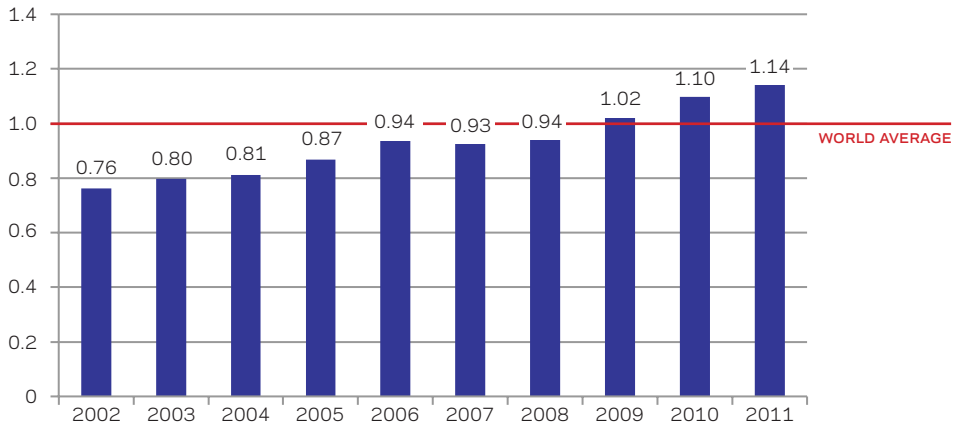


Figure 1.11a — *The overall Field Weighted Citation Impact for AUT, CZE, SVK and POL, 2002-2011.*

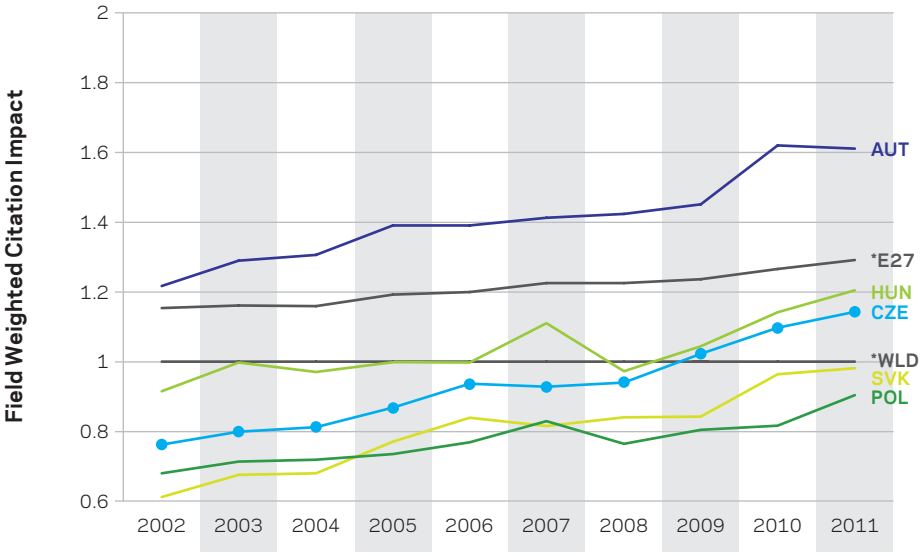
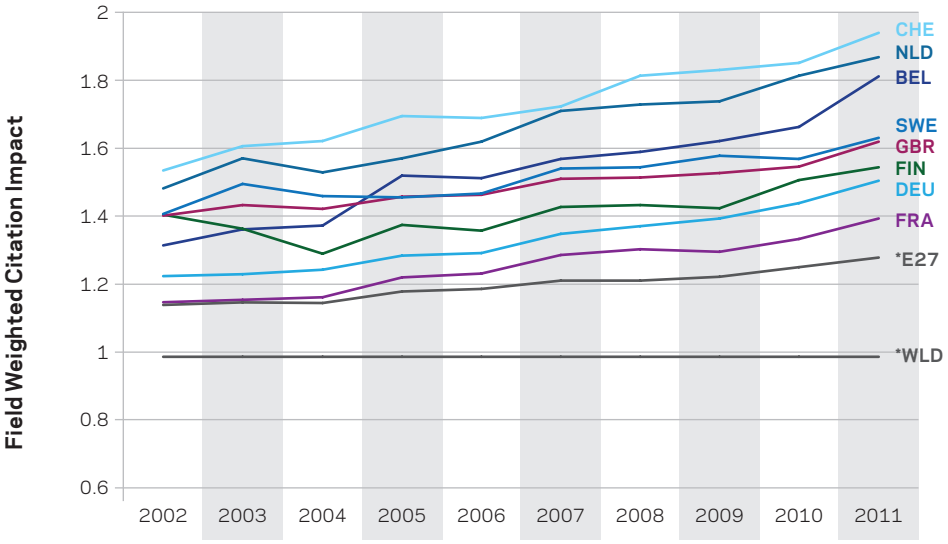


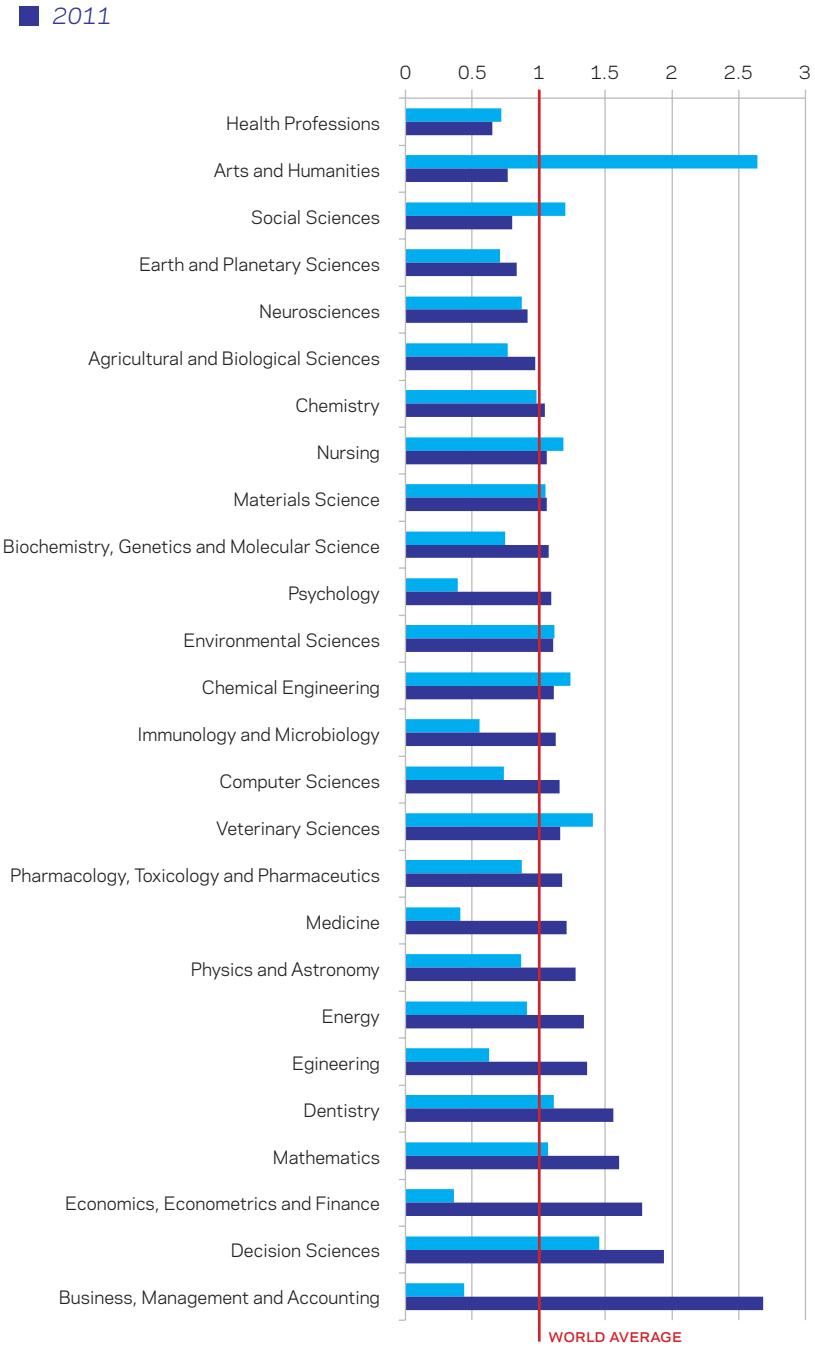
Figure 1.11b — *The overall Field Weighted Citation Impact for CHE, NLD, BEL, SWE, GBR, FIN, DEU and FRA, 2002-2011.*



Taking a closer look at Czech citation impact (Figure 1.12) reveals the field weighted citation impact per subject area. Business, Management and Accounting shows a dramatic increase in impact from far below world level in 2002 and 2006 to 2.7 times world level in 2011. The citation impact of small volumes of articles should always be interpreted with caution, as they may display relatively high (or low) impact levels which may change significantly when the volume of articles increases. Business, Management and Accounting accounted for just 0.9% of Czech output in 2011; we expect field weighted citation impact will decrease should the volume of articles published in this subject increase significantly. We see similar effects in some other subjects (Arts and Humanities, Decision Sciences and Dentistry for example). The Czech Republic has achieved around world average citation impact in Chemistry, which is an area of relative high activity. Perhaps most notably, we see above average field weighted citation impact in Mathematics of 1.6 times world level, which as mentioned is also an area of high activity and growth for the Czech Republic.

Czech citation impact in Physics and Astronomy (representing 17% of Czech science in 2011) has risen from 0.87 times world level in 2002 to 1.27 times world level

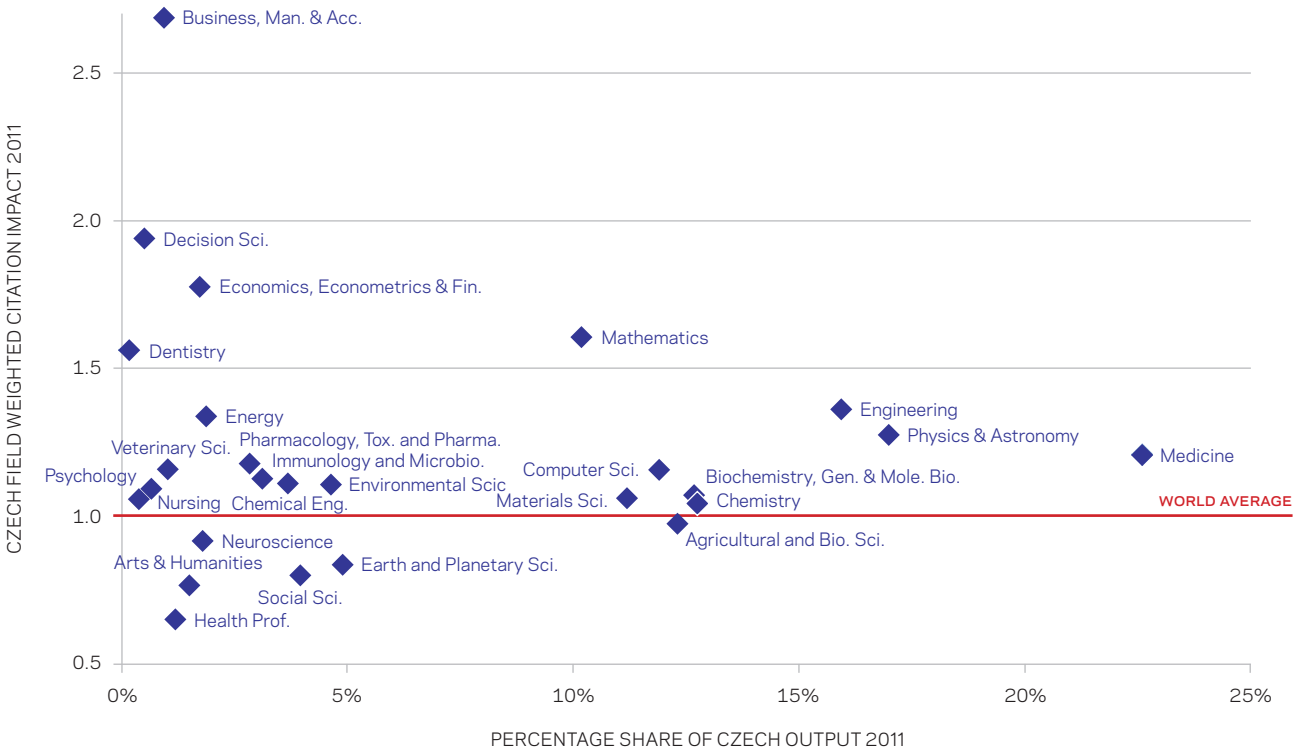
Figure 1.12 — *The Czech Republic's Field Weighted Citation Impact for each subject area 2002-2011.*



by 2011. Computer Science, which grew at 27% per year and represents 11.9% of Czech output in 2011, improved from a field weighted citation impact of 0.74 in 2002 to 1.16 times world level in 2011. Medicine, which represents 22.6% of Czech output and is thereby the largest subject area in 2011, shows increases in field weighted citation impact from just 0.41 in 2002 to 1.21 times world level in 2011. These are significant gains in citation impact, which underlie the overall increase of citation impact for the Czech Republic, and are indicative of increases in quality of research.

Offsetting the publication share that each subject area represents against field weighted citation impact provides another interesting view. We again see that many of the subject areas with the highest citation impact represent the lowest volumes of articles. Turning our focus to the larger volume subject areas, we see that Biochemistry, Genetics and Molecular Biology, Computer Science, Chemistry Materials Science each represent between 11% and 13% of Czech output and show above world average citation impact. Engineering and Physics and Astronomy represent even larger pieces of Czech science and demonstrate even higher above world average citation impact. Medicine, the largest subject area, shows above world average citation impact. As mentioned, Mathematics shows itself to be a growing strength for the Czech Republic.

Figure 1.13 — *Subjects: Percentage share Czech output 2011 vs. Field Weighted Citation Impact 2011.*



Chapter 2
Collaboration

This chapter focuses on collaboration, where we distinguish three types of collaboration: 1. *single* authorship, which refers to publications which are written by just one author; 2. *national* collaboration, which refers to publications which have more than one author, where all authors are affiliated to institutions in the same country; this represents collaboration between fellow countrymen; 3. *international* collaboration, which refers to publications which have more than one author, where at least one author is affiliated to an institution in another country.

2.1 Key Findings

INTERNATIONAL COLLABORATION

37%

In 2011, 37% of Czech authored articles were co-authored with a non-Czech researcher. While this is a higher level of international collaboration than Poland (29.1%) all remaining comparator countries show international collaboration levels of over 40% in 2011. Czech levels of international collaboration have been relatively stable in the last decade, fluctuating between 37% and 40%. Similarly, Hungary, Poland and the Slovak Republic have also not shown increases in international collaboration, which is in contrast to the remaining (and mostly Western European) comparator countries which do show increases in international collaboration.

CITATION IMPACT AND COLLABORATION

2.6X

Looking at the research collaboration of the 13 countries examined in this report, in most cases there is a clear citation advantage that accumulates to internationally co-authored papers, over and above that of nationally co-authored or single authored articles. The Czech Republic's nationally collaborated papers were, on average, cited just as often as their single author papers, while internationally collaborated papers were cited 2.6 times as often – thereby demonstrating the significant contribution that international collaboration can make towards citation impact *within* a country.

COLLABORATION AND CITATION IMPACT

Correlation .8

Examining the relationship between levels of international collaboration and field weighted citation impact, between countries in 2011, reveals a significantly positive correlation of .8 indicating a positive statistical relationship between international collaboration and citation impact. Countries which engage in a higher percentage of international collaboration tend to have higher citation impact than countries which engage less in international collaboration. This is in-line with other studies which also found that internationally co-authored articles, on average, receive more citations than non-international collaborated articles.

HIGH VOLUME COLLABORATION

US, Germany, UK, France, Italy

In 2011 the Czech Republic collaborated most with the United States (1278 co-publications with a field weighted citation impact of 3.18), followed by Germany (1268 co-publications with a field weighted citation impact of 3.11), the UK (930 co-publications with a field weighted citation impact of 4.09), France (910 co-publications with a field weighted citation impact of 3.37) and Italy (643 co-publications with a field weighted citation impact of 3.43).

HIGH IMPACT COLLABORATION

Brazil, Canada, India, Denmark, China

The specific Czech international collaborations that resulted in the highest field weighted citation impact are with Brazil (241 co-publications with a field weighted citation impact of 7.27), Canada (298 co-publications with a field weighted citation impact of 7.07), India (244 co-publications with a field weighted citation impact of 6.84), Denmark (210 co-publications with a field weighted citation impact of 6.25) and China (318 co-publications with a field weighted citation impact of 6.25).

2.2 Collaboration Shares

Looking at the different collaboration types, we see that their relative shares have not changed dramatically in the Czech Republic. The percentage of single author papers in the Czech Republic has decreased from 15% in 2003 to 11.7% in 2011; national collaboration has decreased marginally from 20.3% in 2003 to 19% in 2011; and international collaboration has been fluctuating at around between 37% and 40%.

We see that Switzerland, which shows the highest overall field weighted cited impact of comparator countries, also shows high levels of international collaboration which continue to rise from 56.6% in 2002 to 63.6% in 2011.

Austria, Belgium, Finland, the Netherlands, and Sweden all show collaborations levels of over 50% in 2011. It's worth noting that international collaboration levels are on the rise for all comparator countries with the exception of the Czech Republic, Slovak Republic, Poland and Hungary.

Single authorship is the least common form of publication for most countries, with the exception of the United Kingdom and Poland where we see that single authorship and national collaboration levels are very similar. A question to keep in mind is what relationship these collaboration types have with citation impact and how this may differ from country to country.

Figure 2.1 — *Share of total publication output, per collaboration type.*

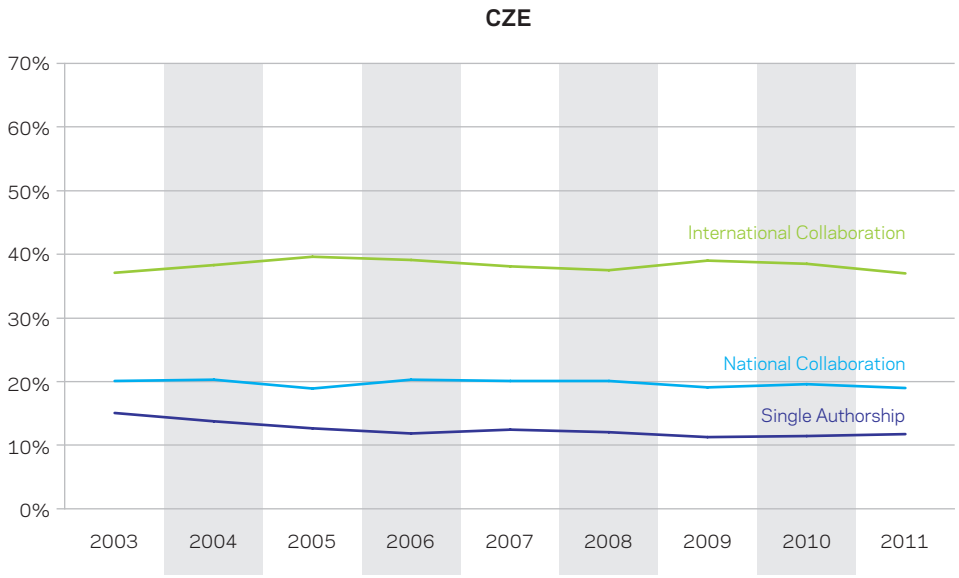
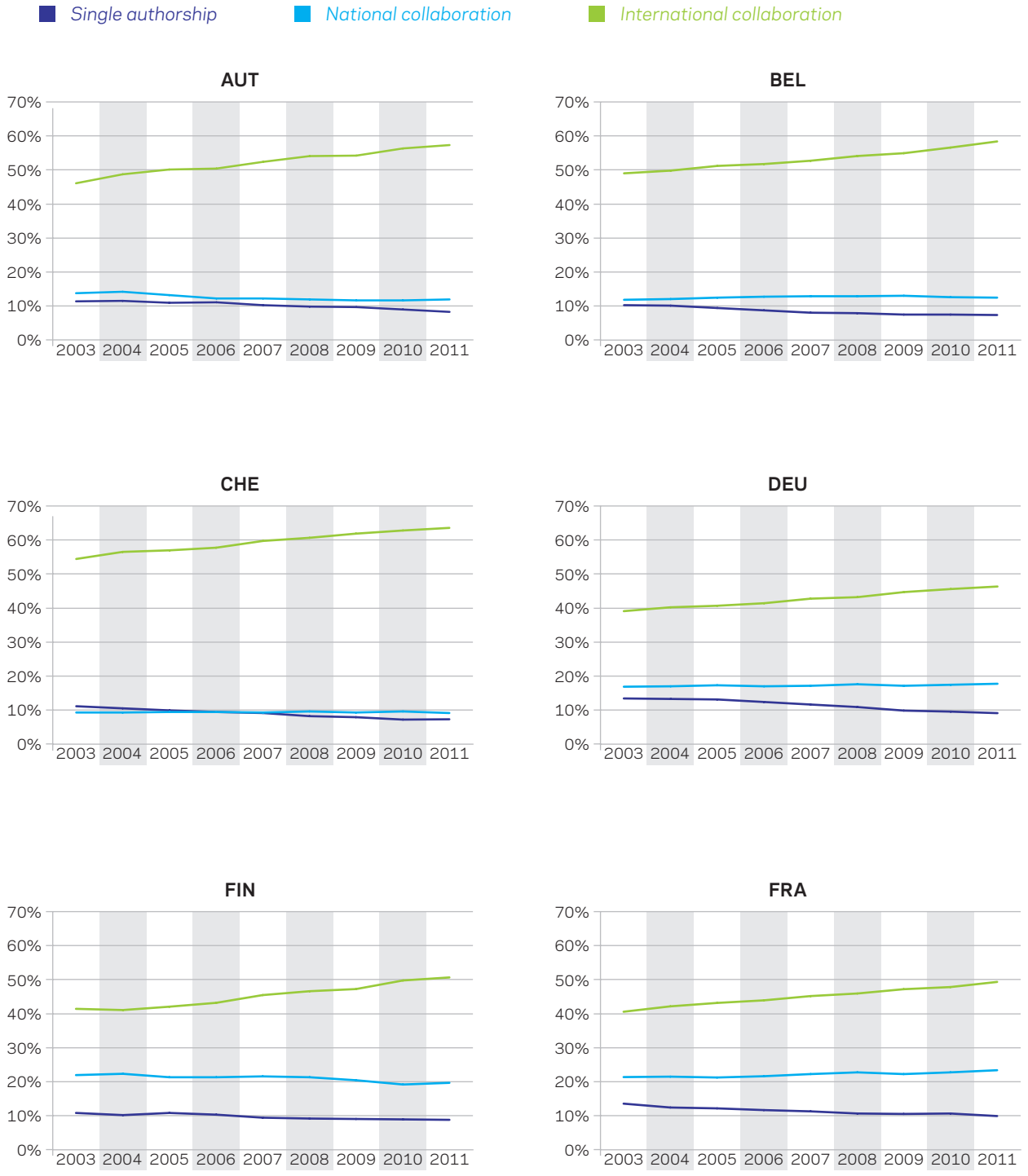
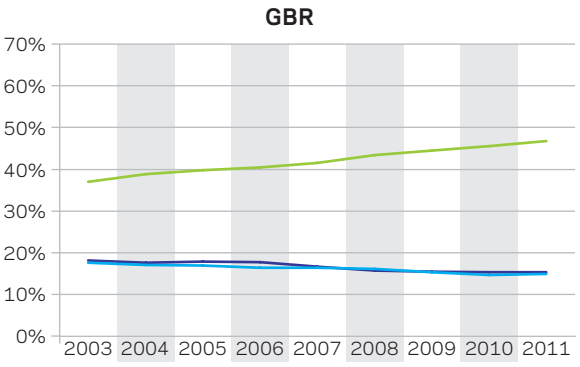


Figure 2.2 — *Share of total publication output, per collaboration type.*

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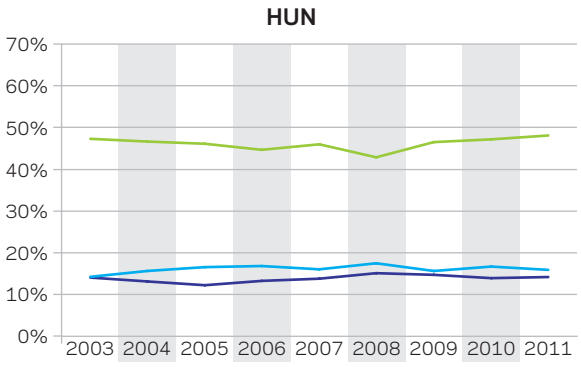
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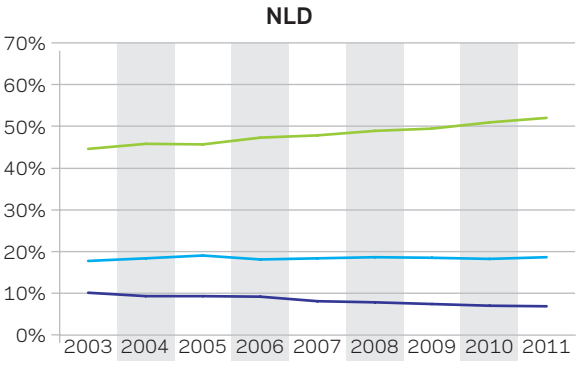
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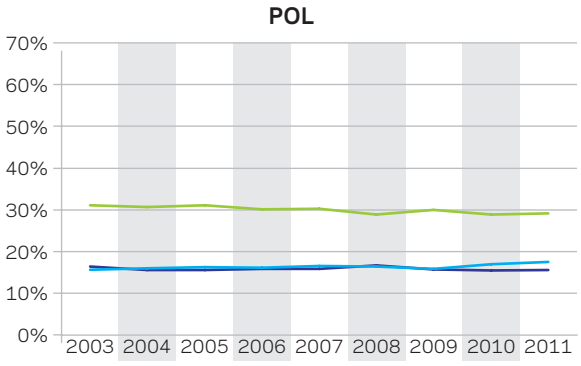
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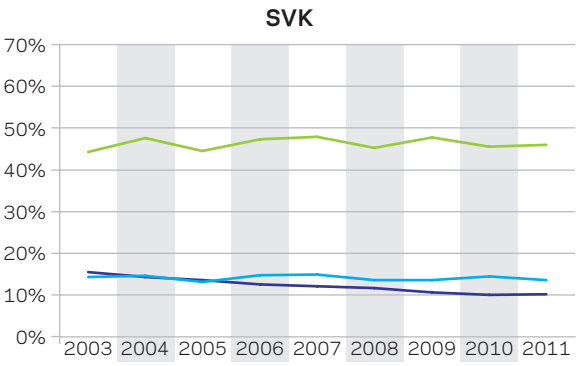
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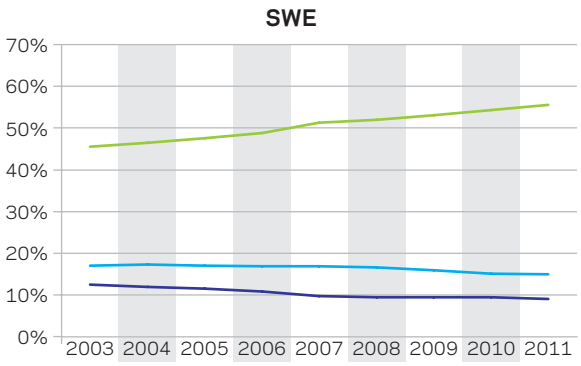
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2.3 Collaboration and Field Weighted Citation Impact

Having looked at what type of collaboration is most frequent, we now examine whether there is a relationship between collaboration and quality of research, as represented by field weighted citation impact. We have therefore calculated the overall field weighted citation impact of each country, but also for each collaboration type separately; i.e. single authored papers, nationally co-authored papers and internationally co-authored papers. This way we can easily see which collaboration type yields the highest citation impact.

It is clear that in most cases, although to varying degrees, international collaboration is on average the most highly cited, and national collaboration, in most cases, is on average more highly cited than single authored papers. In Table 2.3 we have constructed a table that expresses the citations per article fold increase, over single authorship for international and national collaboration in 2011. This was calculated by dividing the field weighted citation impact of each type of collaboration, by the field weighted citation impact of single authored papers, per country.

Table 2.3 — *Citations per article fold increase over single-authorship in 2011.*

	Citations per article fold increase over single-authorship		
	Single Author	**National**	**International**
AUT	1.0	1.8	3.0
BEL	1.0	1.7	2.5
CHE	1.0	2.2	3.3
CZE	**1.0**	**1.0**	**2.6**
DEU	1.0	1.9	2.9
FIN	1.0	1.5	2.3
FRA	1.0	2.1	3.4
GBR	1.0	1.5	2.1
HUN	1.0	1.4	3.1
NLD	1.0	1.5	2.3
POL	1.0	1.1	3.1
SVK	1.0	0.5	1.8
SWE	1.0	1.7	2.6

The Czech Republic's nationally collaborated papers were, on average, cited just as often as its single author papers, but internationally collaborated papers were cited 2.6 times as often – thereby demonstrating the significant contribution that international collaboration can make towards citation impact. We also see that some countries, more than others produce nationally collaborated papers which are cited more often than single authored papers; for example Austrian national collaborations are were cited 1.8 times as often as single authored papers, while their international papers were cited 3 times as often.

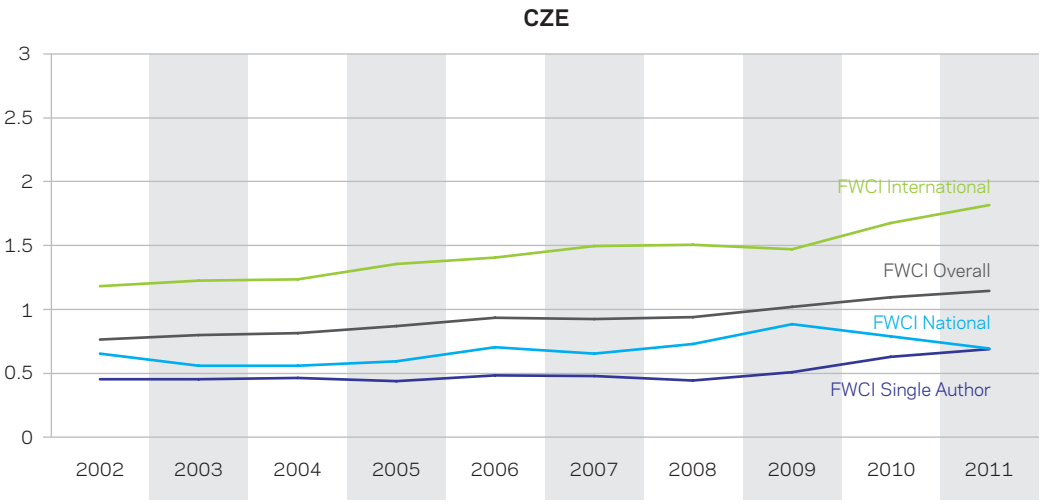
The following pages display Figures of each country's field weighted citation impact per collaboration type, as well as the overall field weighted citation impact for all publication output.

The first thing which stands out from these Figures is that international collaboration yields the highest citation impact within each country. Czech international collaboration yielded a field weighted citation impact of 1.47 in 2009 which rose to 1.8 in 2011, and this is paired with an overall increase in Czech field weighted citation impact from 1.09 in 2009 to 1.14 in 2011. The line representing overall field weighted citation impact shows similarity in shape to the green line representing field weighted citation impact of international articles, suggesting relationship between the two. Interestingly, Czech single authorship papers are being cited more often in 2011 than in previous years, catching up to the level of Czech nationally collaborated papers, which show a decrease in citation impact between 2009 and 2011.

Looking at comparator countries, we observe differences in terms of how much higher the citation impact of international collaboration is compared to national and single authorship. In Poland for example, we see that international co-authored papers yield a citation impact far above that of the country overall, and that national and single authored papers show a citation impact far below that overall average. While in the United Kingdom, we see that nationally co-authored papers yield a citation impact close to the overall average citation impact for the UK.

From this collaboration analysis we conclude that international co-publications tend to be cited most often within each country. If we look closely we see that the line for overall field weighted citation impact often shows similar peaks and curves to the green line representing the field weighted citation impact of solely the international publications of that same country. In Austria for example, we see a significant increase in both between 2009 and 2010, in Hungary

Figure 2.4 — *Field weighted citation impact per collaboration type, and overall.*



we see the same peak in both lines in 2007 and the slopes of the line are parallel as they rise between 2008 and 2011. This may be evidence demonstrating the relationship between international collaboration and overall quality of research as measured by field weighted citation impact.

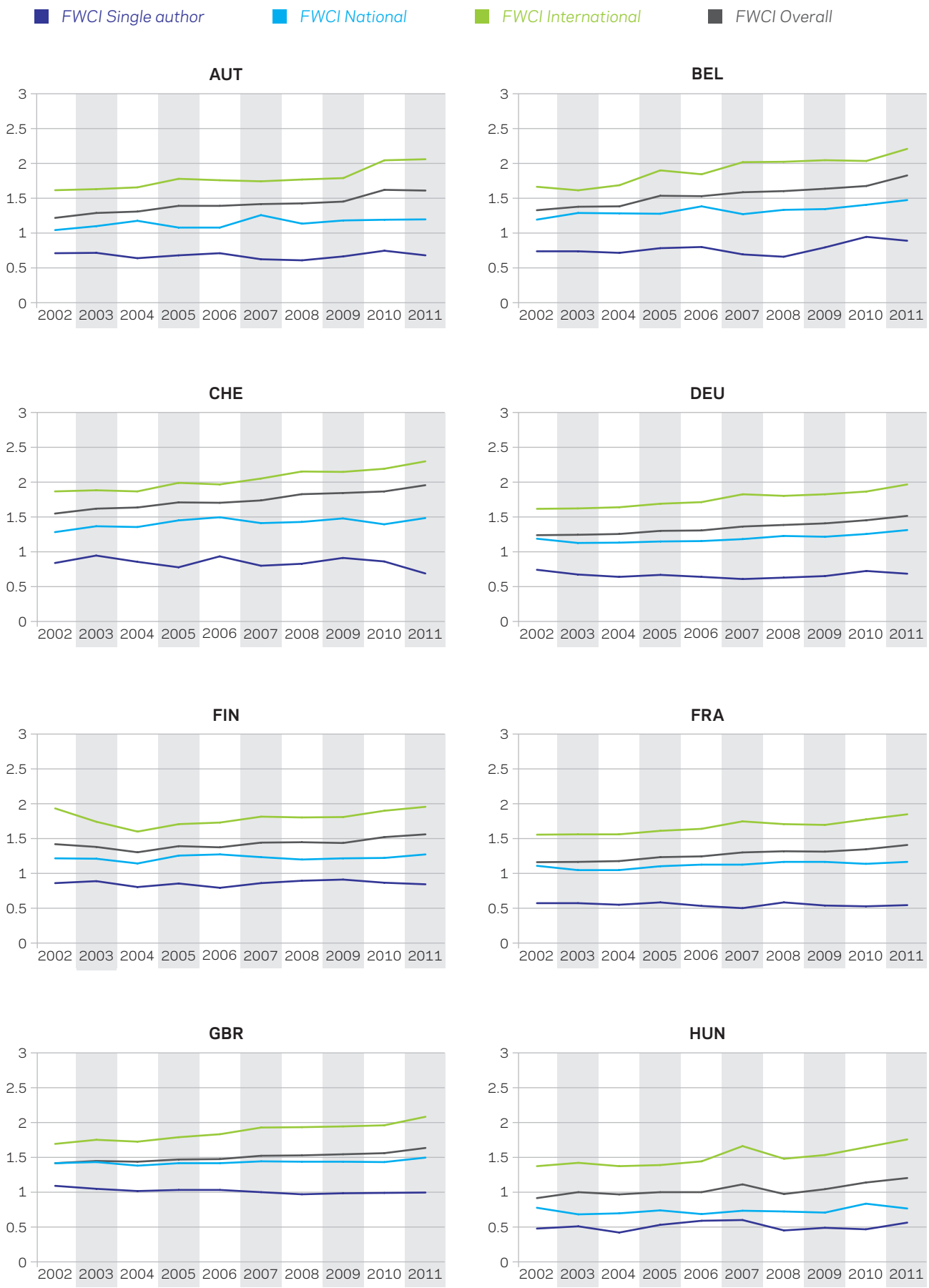
International co-authorship has been the focus of various studies which show that international collaboration is rising globally and is positively related to citation impact. In an increasingly globalized world it is not surprising to see that international collaboration has been rising [4]. In this study we have so far noted the positive relationship *within* each country and we have also noted that of the comparator countries, those with high citation impact also demonstrate high levels of international collaboration. For example, Switzerland shows the highest field weighted citation impact (1.96 in 2011) as well as highest levels of international collaboration (63.6% in 2011). This leads us to wonder whether our data also supports a relationship between international collaboration and citation impact between countries. Do countries which collaborate more internationally, really yield a higher overall citation impact?

To examine this, we have offset the level of international collaboration against field weighted citation impact of each country in 2011 (Figure 2.5). The result is a correlation of .8 between international collaboration and citation impact which indicates a significant positive relationship. Countries which collaborate more internationally tend to have higher citation impact than countries which collaborate less internationally. This is in line with other studies which also find that internationally co-authored articles, on average, receive more citations than non-international collaborated articles.

This study shows that Czech levels of international collaboration are relatively low when contrasted against the selected comparator countries, but perhaps more significantly, Czech international collaboration has not been increasing, as is the case with other Eastern European countries.

[4] Glanzel, W. (2001). National characteristics in international scientific co-authorship relations. *Scientometrics*, 51(1) pp. 69-115.; He, T. (2009). International scientific collaboration of China with the G7 countries. *Scientometrics*, 80(3) pp. 571-582.

Figure 2.4 — *Field weighted citation impact per collaboration type, and overall.*



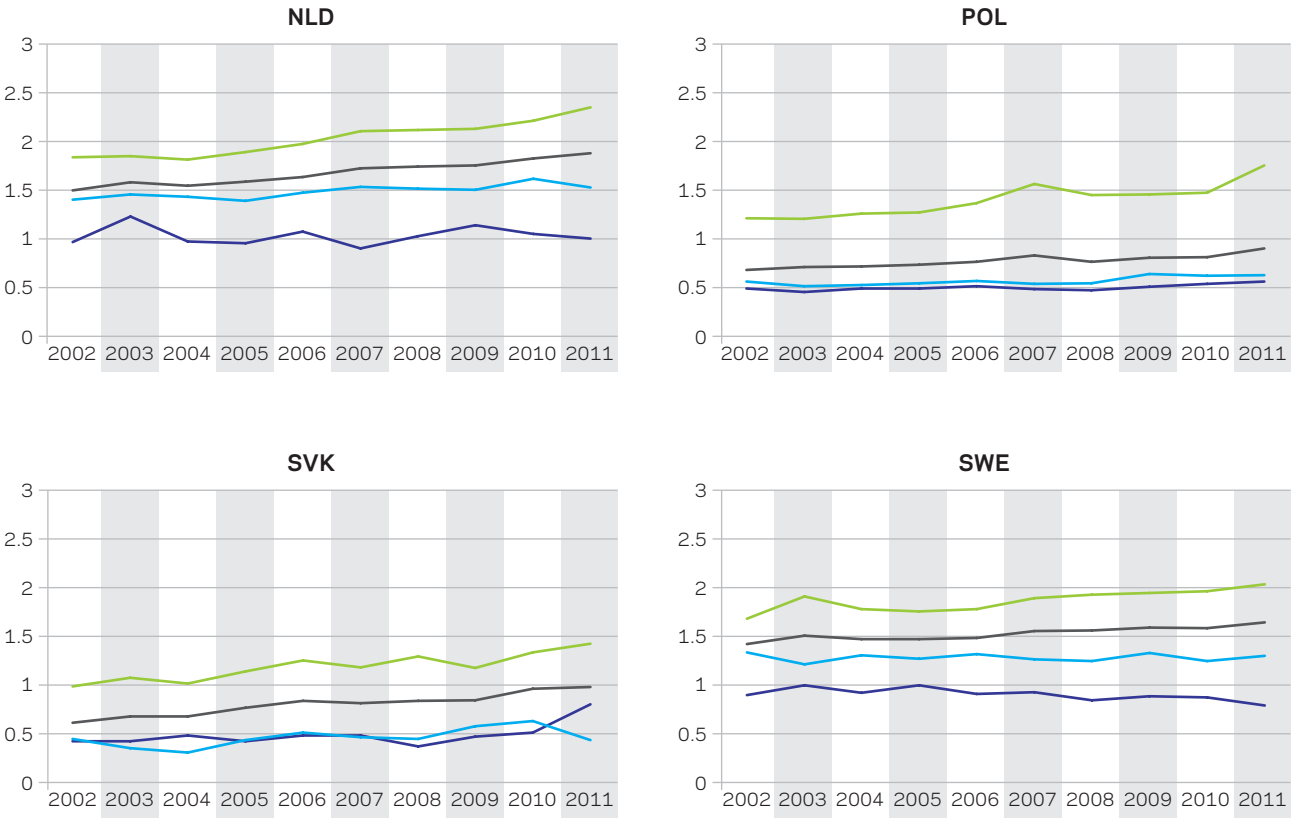
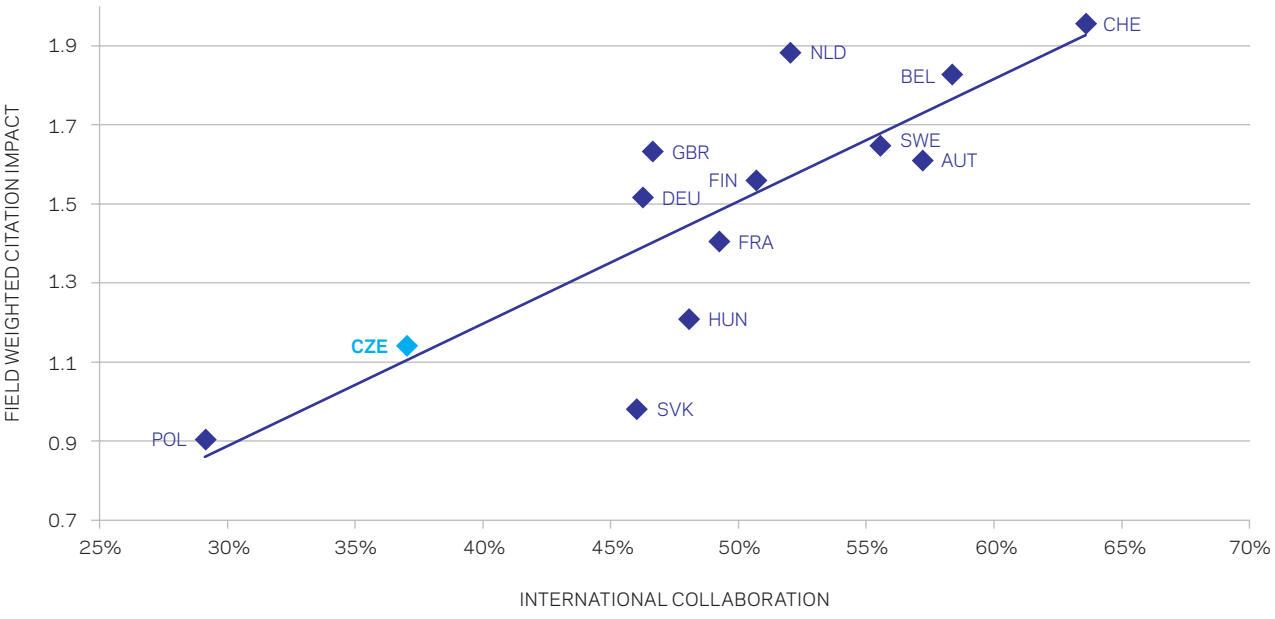


Figure 2.5 — *Percentage International Collaboration 2011 vs. Field Weighted Citation Impact 2011.*



2.4 The Czech Republic's Top Collaboration Partners

This section specifies the 'top' collaboration partners of the Czech Republic. We have defined the top collaborators by looking at the number of co-publications each country has written with the Czech Republic in 2011 and by looking at the field weighted citation impact of those co-publications in 2011.

Top collaborators based on volume of co-publications with Czech Republic

Table 2.6 displays the top 20 collaboration partners of the Czech Republic ranked on the number of co-publications each country has written with the Czech Republic in 2011. The table displays the field weighted citation impact of those co-publications in addition to the overall number of co-publications.

In 2011 the Czech Republic collaborated most with the United States (1278 co-publications with a field weighted citation impact of 3.18), followed by Germany (1268 co-publications with a field weighted citation impact of 3.11), the UK (930 co-publications with a field weighted citation impact of 4.09), France (910 co-publications with a field weighted citation impact of 3.37) and Italy (643 co-publications with a field weighted citation impact of 3.43). See Table 2.6 for the complete top 20.

Keeping in mind that the Czech Republic's overall field weighted citation impact in 2011 is 1.14, this again demonstrates the relationship between international collaboration and citation impact. Looking at the entire table of collaboration partners we observe that collaboration with all these countries leads to high levels of field weighted citation impact.

Offsetting the number of co-publications with the Czech Republic in 2011 against the field weighted citation impact of those co-publications results in Figure 2.7. This visualization of the data demonstrates that many of these collaborations achieve field weighted citation impact of over 3 times world level, with the exception of collaboration with the Slovak Republic. It also demonstrates that lower volumes publications often achieve relatively high citation impact (see the cluster of countries which produce between 200 and 400 co-publications with the Czech Republic).

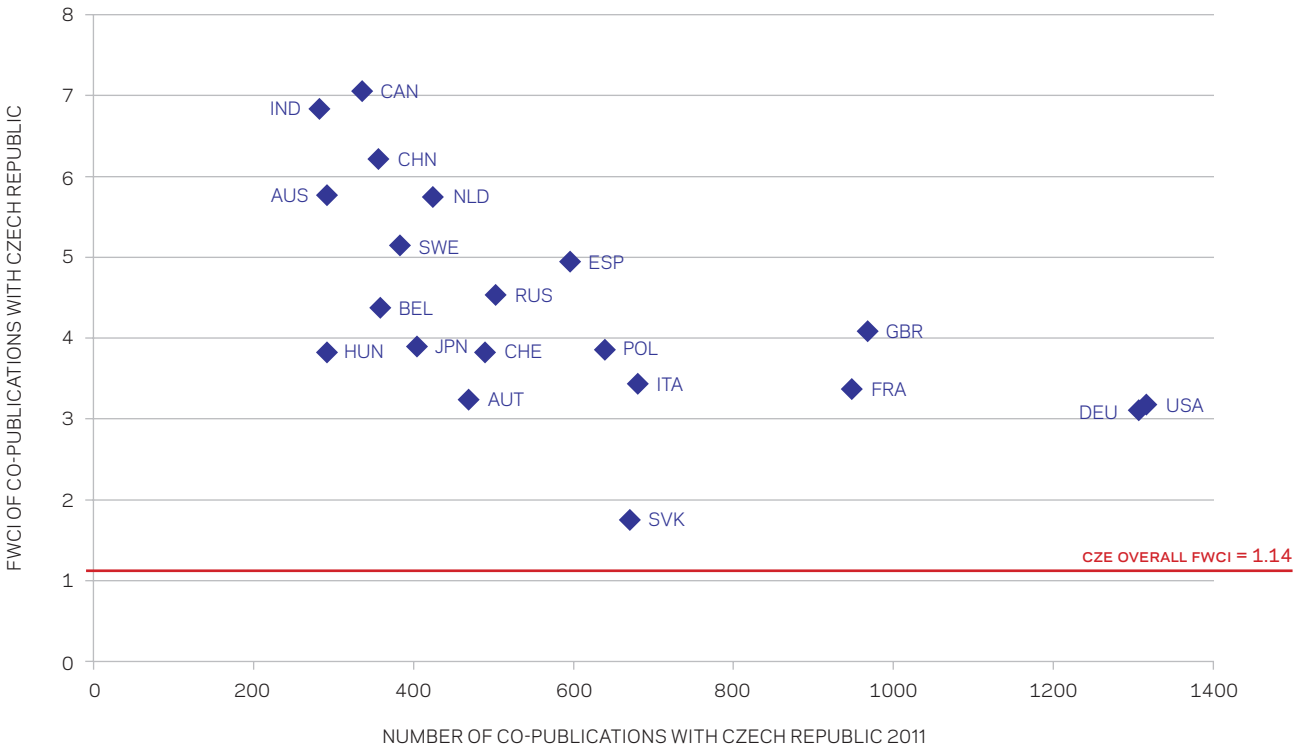
Table 2.6 — *Top 20 collaborators with Czech Republic based on the number of co-publications in 2011.*

	Co-Publications (2011)	FWCI (2011)
United States	1278	3.18
Germany	1268	3.11
United Kingdom	930	4.09
France	910	3.37
Italy	643	3.43
Slovak Republic	632	1.75
Poland	601	3.85
Spain	558	4.94
Russian Federation	464	4.54
Switzerland	451	3.83
Austria	431	3.24
Netherlands	387	5.75
Japan	367	3.91
Sweden	345	5.15
Belgium	320	4.37
China	318	6.21
Canada	298	7.07
Australia	254	5.76
Hungary	254	3.82
India	244	6.84

Top collaborators based on field weighted citation impact of co-publications with Czech Republic

Table 2.8 displays the top 20 collaboration partners of the Czech Republic ranked on the field weighted citation impact of co-publications each country has written with the Czech Republic in 2011. As previously mentioned, it is common that low volumes of articles show relatively high citation impact. We have therefore filtered out collaborations that had less than 200 co-publications in 2011, from the list below. The specific Czech international collaborations that resulted in the highest field weighted citation impact are those with Brazil (241 co-publications with a field weighted citation impact of 7.27), Canada (298 co-publications with a field weighted citation impact of 7.07), India (244 co-publications with a field weighted citation impact of 6.84),

Figure 2.7 — *Top 20 Czech collaborators based on volume: number of co-publications 2011 vs. FWCI of co-publications 2011.*



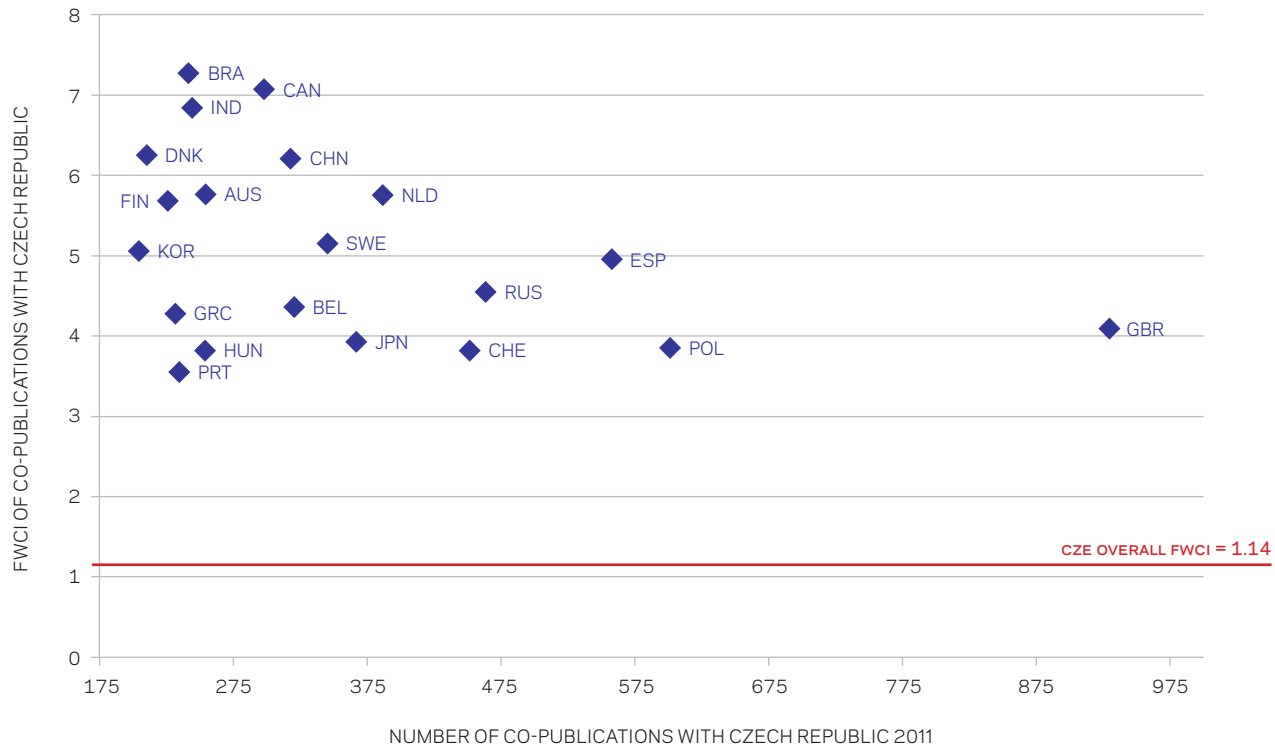
Denmark (210 co-publications with a field weighted citation impact of 6.25) and China (318 co-publications with a field weighted citation impact of 6.25).

Offsetting the number of co-publications with the Czech Republic in 2011 against the field weighted citation impact of those co-publications results in Figure 2.9. This visualization of the data demonstrates that some of these top collaborations achieve field weighted citation impact of over 6 or 7 times world level; that most of them achieve a field weighted citation impact of over 4 times world level, and that all of them achieve field weighted citation impact of over 3 times world level. Keeping in mind that the Czech Republic's overall field weighted citation impact in 2011 is 1.14 this demonstrates the high relative impact that international collaboration can yield.

Table 2.8 — *Top 20 collaborators with Czech Republic.*

	Co-Publications (2011)	FWCI (2011)
Brazil	241	7.27
Canada	298	7.07
India	244	6.84
Denmark	210	6.25
China	318	6.21
Australia	254	5.76
Netherlands	387	5.75
Finland	226	5.68
Sweden	345	5.15
Korea	205	5.06
Spain	558	4.94
Russian Federation	464	4.54
Belgium	320	4.37
Greece	232	4.28
United Kingdom	930	4.09
Japan	367	3.91
Poland	601	3.85
Switzerland	451	3.83
Hungary	254	3.82
Portugal	235	3.54

Figure 2.9 — *Top 20 Czech collaborators based on FWCI: number of co-publications 2011 vs. FWCI of co-publications 2011.*



Chapter 3
Full-Text Article Downloads

Full Text Article Download data derived from Elsevier's ScienceDirect database (which provides article download data for approximately 20% of the world's published journal articles) offers a different perspective from citations and may be interpreted as representing the interest in, or usefulness of an article to the community it is aimed at.

3.1 Key Findings

"It can be hypothesized that the number of downloads primarily reflects a community's awareness of a paper, in terms of its availability and particularly its face value. Scientists may read – and in this sense use – many papers in their research, but during the research process and the writing their own papers, they sort out the articles worth citing and those that are less so. Thus, downloads and citations relate to distinct phases in the process of collecting and processing relevant scientific information that eventually leads to the publication of a journal article, the former being located more in the beginning, and the latter more towards the end of it." (Moed, H., 2005)

WORLD DOWNLOAD SHARE

0.6%

Czech Republic authored articles received 0.4% of world downloads in 2002 and this share rose to 0.6% in 2011. This is similar to the observed level of Czech citations which rose from 0.4% in 2002 to 0.7% in 2011.

DECREASING WORLD DOWLOAD SHARE

UK, Germany

UK and Germany have decreased their share of world downloads; the UK from 10.9% in 2002 to 9.2% in 2011 and Germany from 7.5% in 2002 to 7.1% in 2011. This is a different pattern than we observed for citations, where the UK and Germany show a stable and gentle rising trend in share of world citations.

DOWNLOAD IMPACT

0.88

The Czech Republic's download impact was 0.72 in 2002, indicating that Czech publications were downloaded 72% of the world average number of downloads per paper. By 2011 Czech download impact has risen to 0.88 indicating that publications were downloaded 88% of the world average number of downloads per paper – which is still below the world average.

AVERAGE DOWNLOADS

273X

Czech papers published in 2002 in Elsevier journals, have on average been downloaded 603 times each (compared to a world average of 838 downloads per paper). Czech papers published in 2011 in Elsevier journals, have on average been downloaded 273 times each (compared to a world average of 309 downloads per paper).

Article downloads accumulate over time, just as citations do; older publications have more time to accumulate citations as well as downloads. Therefore, similar to the approach we used for citations, we look at the percentage of world downloads received for each country rather than at absolute numbers of downloads.

Table 3.1 displays the percentage of total world full-text article downloads in ScienceDirect for each country. The Czech Republic received 0.4% of world downloads in 2002 and this rose to 0.6% by 2011. This is similar to the observed level of Czech citations received which rose from 0.4% in 2002 to 0.7% in 2011. Looking at the overall picture we observe that the UK and Germany have decreased their share of world downloads (UK from 10.9% in 2002 to 9.2% in 2011, Germany from 7.5% in 2002 to 7.1% in 2011) which is a different pattern than we observed for citations, where the UK and Germany show a stable or gentle rising trend in share of world citations.

We must keep in mind that our citation analysis is based on the Scopus database which contains articles from Elsevier as well as many other publishers, while this download analysis is based solely on articles published in Elsevier

Table 3.1 — *Percentage of total world full-text article downloads in ScienceDirect.*

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
AUT	0.9%	1.0%	1.0%	1.0%	0.9%	1.0%	1.0%	0.9%	1.0%	1.0%
BEL	1.6%	1.6%	1.8%	1.7%	1.7%	1.7%	1.8%	1.8%	1.8%	1.9%
CHE	2.1%	2.2%	2.3%	2.2%	2.1%	2.1%	2.0%	2.2%	2.2%	2.5%
CZE	**0.4%**	**0.5%**	**0.5%**	**0.5%**	**0.5%**	**0.5%**	**0.5%**	**0.5%**	**0.6%**	**0.6%**
DEU	7.5%	7.4%	7.1%	6.9%	6.8%	6.5%	6.3%	6.5%	7.0%	7.1%
FIN	1.1%	1.0%	1.0%	1.0%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%
FRA	6.4%	6.3%	6.2%	6.5%	6.0%	5.8%	5.9%	5.8%	5.9%	6.0%
GBR	10.9%	10.9%	10.5%	10.4%	10.0%	9.6%	9.4%	9.3%	9.5%	9.2%
HUN	0.5%	0.5%	0.5%	0.5%	0.5%	0.4%	0.4%	0.4%	0.4%	0.4%
NLD	3.4%	3.3%	3.2%	3.3%	3.1%	3.2%	3.1%	3.2%	3.7%	3.6%
POL	0.9%	1.0%	1.0%	1.1%	1.0%	1.0%	0.9%	1.0%	0.9%	1.1%
SVK	0.1%	0.1%	0.2%	0.1%	0.2%	0.2%	0.1%	0.1%	0.1%	0.2%
SWE	2.2%	2.3%	2.1%	2.1%	2.0%	1.9%	1.8%	1.8%	2.0%	1.8%
*E27	40.8%	40.3%	39.1%	39.4%	38.5%	38.0%	37.6%	37.5%	38.3%	37.5%

Table 3.2 — *Number of full-text article downloads per paper.*

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
AUT	877	1,027	1,071	1,089	865	847	779	733	572	347
BEL	914	1,050	1,206	1,123	966	904	862	818	616	381
CHE	985	1,162	1,294	1,279	991	930	889	833	657	423
CZE	**603**	**714**	**794**	**824**	**721**	**643**	**585**	**554**	**427**	**273**
DEU	819	962	1,029	1,012	833	778	729	700	571	343
FIN	955	1,090	1,160	1,176	834	811	766	696	596	358
FRA	741	884	945	944	790	728	666	613	473	296
GBR	1,051	1,254	1,322	1,258	922	861	780	750	613	373
HUN	664	800	891	804	708	710	633	469	356	217
NLD	1,061	1,280	1,336	1,291	975	964	891	825	700	417
POL	521	627	664	694	599	556	496	471	328	216
SVK	561	686	731	785	705	626	555	512	353	238
SWE	965	1,227	1,215	1,197	871	833	750	748	650	363
*E27	848	1,014	1,072	1,037	830	783	718	673	529	319
*WLD	838	1,009	1,085	1,041	817	769	704	655	504	309

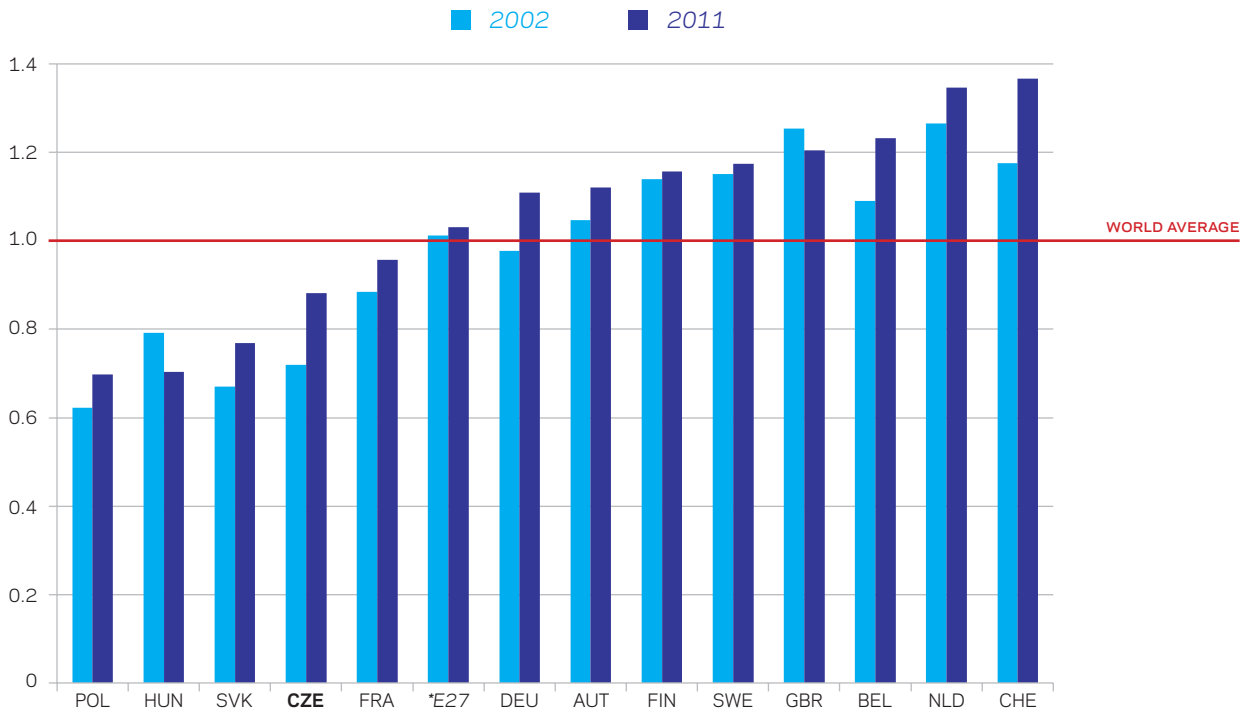
journals, which are available to customers for download in ScienceDirect and represents approximately 20% of what is in Scopus.

Table 3.2 displays the number of downloads per paper for each country, and the EU27 and World benchmarks. Here we see clearly that older papers have on average been downloaded more often than recent publications. Czech papers published in 2002 in Elsevier journals, have on average been downloaded 603 times each (compared to a world average of 838 downloads per paper); Czech papers published in 2011 in Elsevier journals, have on average been downloaded 273 times each (compared to a world average of 309 downloads per paper).

Inclusion of the world benchmark for downloads per paper allows the calculation of relative download *impact*, which is calculated by dividing the number of downloads per paper of a country, by the number of downloads per paper in the entire world, in the same year. If the resulting metric is above 1 then papers have been downloaded more than world average, and if it is below 1 then they have been downloaded less than the world average. Figure 3.3 (below) shows the relative download impact for each country in 2002 and 2011. We have ranked the countries so that those with the lowest relative download impact in 2011 are displayed on the left, and those with the highest on the right.

The Czech Republic's download impact was 0.72 in 2002, indicating that Czech publications were downloaded 72% of the world average number of downloads per paper. By 2011 Czech download impact has risen to 0.88 indicating that publications were downloaded 88% of the world average number of downloads per paper – which is still below the world average. This finding is different from what we observed in our citation analysis, where we saw that Czech citation impact has gone from below world average to above world average in the same ten year time period. We see increases in download impact for every country with the exception of Hungary and the United Kingdom, which both show decreases. We should keep in mind that the relationship between downloads and citations is still largely unknown, and that the citation analysis is based on all records in Scopus (i.e. Elsevier as well as 5000 other publishers) while the download analysis uses only the subset of that data which has been published in Elsevier journals, constituting approximately 20% the publications in Scopus.

Figure 3.3 — *Relative download impact for each country in 2002 and 2011.*



Chapter 4
Top Czech Institutions

This section identifies which institutions have contributed most to Czech scientific output in terms of volume of publications, and provide some basic bibiliometrics for those institutions: publication output in 2002 and 2011; the compound annual growth rate thereof for that ten year period; the field weighted citation impact of each institution's publication output, again for the years 2002 and 2011; and the levels of international collaboration in those years.

4.1 Key Findings

CITATION IMPACT

Increase in quality of research

Looking at the ten Czech institutions which produced the highest volume of publication output in 2011, we observe increases in quality of research, as measured by field weighted citation impact, between 2002 and 2011, for all but one of these institutions. This is in line with the observed overall increase in Czech field weighted citation impact.

TOP INSTITUTION

Czech Academy of Sciences (CAS)

Czech Academy of Sciences (CAS) as a group of institutions produces the highest volume of publications; having published 3885 articles in 2011, which represents 26.2% of the total Czech output in that year. CAS also shows the highest levels of international collaboration of 53.8% in 2011.

CITATION IMPACT

CAS above world average since 2002

CAS overall field weighted citation impact has been above world average since 2002 and shows an increasing trend representing improvements of overall quality of research in the last decade which, given the large share of Czech science this represents, may be seen as a significant contribution towards the overall increases in citation impact we observe for the Czech Republic.

CITATION IMPACT

Significant increase Charles University

Charles University shows relatively high levels of output paired with a significant increase in citation impact from 0.80 in 2002 to 1.44 in 2011.

Table 4.1 —*Top ten Czech institutions ranked on number of publications in 2011.*

	Total Publications			Field Weighted Citation Impact		International Collaboration	
	2002	2011	CAGR	2002	2011	2002	2011
**Czech Republic*	6298	14823	10%	0.76	1.14	31.0%	37.0%
Czech Academy of Sciences	2334	3885	5.8%	1.02	1.25	47.0%	53.8%
Charles University	1288	3200	10.6%	0.80	1.44	34.5%	47.1%
Czech Technical University	279	1395	19.6%	0.67	1.19	30.8%	37.0%
Masaryk University	390	1054	11.7%	0.73	1.15	25.9%	37.3%
Brno University of Technology	116	848	24.7%	0.71	1.12	15.5%	19.0%
Palacky University	207	702	14.5%	0.84	1.62	24.6%	42.2%
University Ostrava	32	545	37.0%	1.15	1.18	21.9%	29.5%
Technical University in Ostrava	44	520	31.6%	0.58	1.15	18.2%	27.1%
South Bohemia University	118	452	16.1%	1.05	1.00	39.0%	50.2%
Tomas Bata University in Zlin	32	377	31.5%	0.86	2.90	18.8%	14.3%

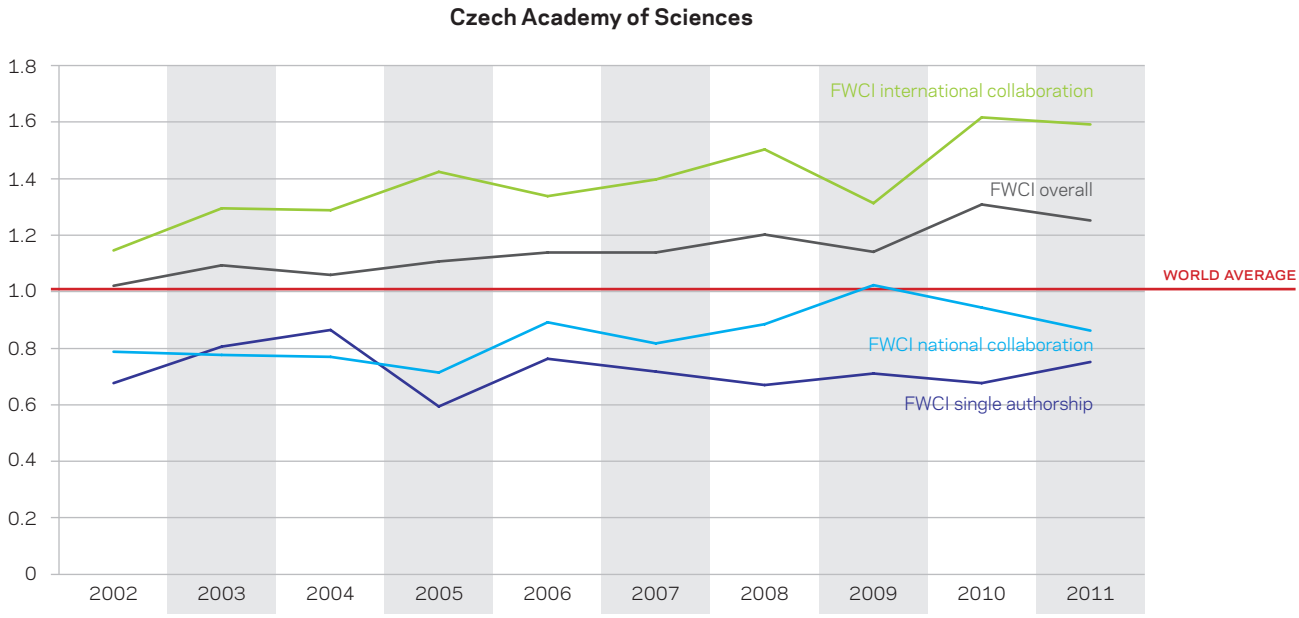
Table 4.1 displays the number of publications, compound annual growth rate, field weighted citation impact and levels of international collaboration for the years 2002 and 2011, for the ten Czech institutions which produced the highest volume of publication output in 2011.

Looking at the ten most active Czech institutions, we see that many of these institutions are growing quickly and the quality of research as measured by field weighted citation impact has increased between 2002 and 2011 (for all but one of these institutions). This is in line with the overall increase in Czech field weighted citation impact. In terms of international collaboration we see some variance between institutions, ranging from below 20% to above 50%. The Czech Academy of Sciences leads the way in terms of collaboration; 53.8% of their articles were co-published with at least one author in another country.

The most productive Czech Institutions in terms of yearly publication output include Charles University, Czech Technical University, Masaryk University, and Brno University of Technology (see Table 4.1 for the complete top 10). The Czech Academy of Sciences, being a large group of institutions, clearly produces the largest volume of publication output; having published 3885 articles in 2011, it represents 26.2% of the Czech Republic's total publication output. That said, the compound annual growth rate of the Czech Academy of Sciences is 5.8% - which is lower than the overall Czech growth rate. All other institutions in this overview are growing faster than 10% which means the Czech Academy of Sciences' share of total Czech output is decreasing over time.

Figure 4.2 (below) provides a closer look at the field weighted citation impact of the Czech Academy of Sciences (CAS) publications for all CAS output, CAS international co-publications, CAS national co-publications and CAS single authored publications. CAS overall field weighted citation impact has been above world average since 2002 and shows an increasing trend representing improvements of overall quality of research in the last decade. Given the large share of Czech science this represents, it is a significant contribution towards the overall increases in citation impact we observe for the Czech Republic. CAS international co-publications show the highest field weighted citation impact, in line with our previously discussed findings at a country level. We again observe the similarity in trend and shape between the lines representing international collaboration FWCI and overall FWCI. CAS national collaboration's field weighted citation impact is seen to have increased from 2002 with a peak of above 1 (which is world average level of all documents) in 2009 and a subsequent decline in 2010 and 2011.

Figure 4.2 — *Field weighted citation impact per collaboration type and overall for the Czech Academy of Sciences.*



APPENDIX A **METHODOLOGY**

Methodology and rationale

Our methodology is founded upon the theoretical principles and best practices developed in the field of quantitative science and technology studies, particularly in science and technology indicators research. The Handbook of Quantitative Science and Technology Research: The Use of Publication and Patent Statistics in Studies of S&T Systems (Moed, Glänzel and Schmoch, 2004) [5] gives a good overview of this field and is based on the pioneering work of Derek de Solla Price (1978) [6], Eugene Garfield (1979) [7] and Francis Narin (1976) [8] in the USA, and Christopher Freeman, Ben Martin and John Irvine in the UK (1981, 1987) [9], and in several European institutes including the Centre for Science and Technology Studies at Leiden University, the Netherlands, and the Library of the Academy of Sciences in Budapest, Hungary.

The analyses of bibliometric data in this report are based upon recognised advanced indicators (e.g., the concept of relative citation impact rates). Our base assumption holds that such indicators are useful and valid, though imperfect and partial measures, in the sense that their numerical values are determined by research performance and related concepts, but also by other, influencing factors that may cause systematic biases. In the past decade, the field of indicators research has developed a best practice as to how indicator results should be interpreted and which influencing factors should be taken into account. With our methodology we build further on these practices.

Document types

For all bibliometric analysis, only the following document types are considered:

- Article (ar)
- Review (re)
- Conference Proceeding (cp).

We use the terminology publications, articles, documents, and papers throughout this report. These terms are used interchangeably; they refer to exactly the same thing.

CAGR: Compound Annual Growth Rate

The year-over-year constant growth rate over a specified period of time. Starting with the first value in any series and applying this rate for each of the time intervals would yield the amount in the final value of the series.

$$CAGR\,(t_0, t_n) = (V\,(t_n) / V\,(t_0))^{\frac{1}{t_n - t_0}} - 1$$

$V\,(t_0)$: start value, $V\,(t_n)$: finish value, $t_n - t_0$: number of years.

Counting

All analyses make use of whole counting rather than fractional counting. For example, if a paper has been co-authored by one author from the Czech Republic and one author from the Netherlands, then that paper is whole counted towards both the publication count of the Czech Republic, as well as the publication count of the Netherlands. Similarly, if a paper is published in a journal which is classified as being related to two subject areas, then that paper is whole counted towards the publication count of both of those subject areas. Total counts for each country are the unique count of publications.

Data Sources

Scopus has been developed by and is owned by Elsevier. It is the largest abstract and citation database of research literature in the world, with abstracts and citation information from more than 49 million scientific research articles in 19,500 peer-reviewed journals (including 1,900 Open Access journals) published by over 5,000 publishers spanning all science sectors, including the Arts & Humanities (Scopus covers more than 3,000 publications in the field of Arts & Humanities). Scopus includes 28 million records back to 1996 (of which 78% include citing and cited references); 21 million records pre-1996 which go back as far as 1823 and 5.3 million conference papers from proceedings and journals. Approximately 2 million new records are added to Scopus each year via daily updates.

ScienceDirect is Elsevier's full-text journal articles platform. ScienceDirect is a leading full-text scientific platform. With an invaluable and incomparable customer base, the use of scientific research on ScienceDirect.com will provide a different look at performance measurement. ScienceDirect.com is used by more than 12,000 institutions worldwide,

with more than 11 million active users and over 600 million full-text article downloads in 2010. The average click through to full-text per month is 50 million. More info can be found at www.info.sciverse.com/sciencedirect.

Research Quantity and Quality Indicators

Publication output: The number of publications per country, which have at least one author affiliated to an institution which is in that country. A publication which is co-authored by authors from different countries, thus counts towards the publication output of each country.

Publication share: The global share of publications for a specific country expressed as a percentage. Using a global share in addition to absolute numbers of publications provides insight by normalizing for increases in world publication growth and expansion of the Scopus database.

Citation share: The global share of citations for a specific country expressed as a percentage. Using a global share in addition to absolute numbers of publications provides insight by normalizing for increases in world publication growth and expansion of the Scopus database.

Field Weighted Citation Impact: An indicator representing the quality of research as based on the average number of citations received by a group of papers compared to the world number of citations received by the same type of papers. This metric is field weighted in that it adjusts for differing citation practices in different subject fields and therefore of the different subject emphases of comparator countries.

Subject classification

This report has applied the All Science Journal Classification (ASJC) to assign publications to subject areas. Titles in Scopus are classified under four broad subject clusters (life sciences, physical sciences, health sciences and social sciences & humanities) which are further divided into 27 major subject areas and 300+ minor subject areas. Titles may belong to more than one subject area. We have reported on the 27 major subject area level.

ISO country codes

The table below shows the ISO country codes used in this report and the countries they represent, as well as the codes we have used to represent the World and Europe.

Code	Definition
AUT	Austria
BEL	Belgium
CHE	Switzerland
CZE	Czech Republic
DEU	Germany
FIN	Finland
FRA	France
GBR	United Kingdom
HUN	Hungary
NLD	Netherlands
POL	Poland
SVK	Slovak Republic
SWE	Sweden
*EU27	Europe as a whole
*WLD	World as a whole

[5] Moed H., Glänzel W., & Schmoch U. (2004), *Handbook of Quantitative Science and Technology Research*, Kluwer, Dordrecht.

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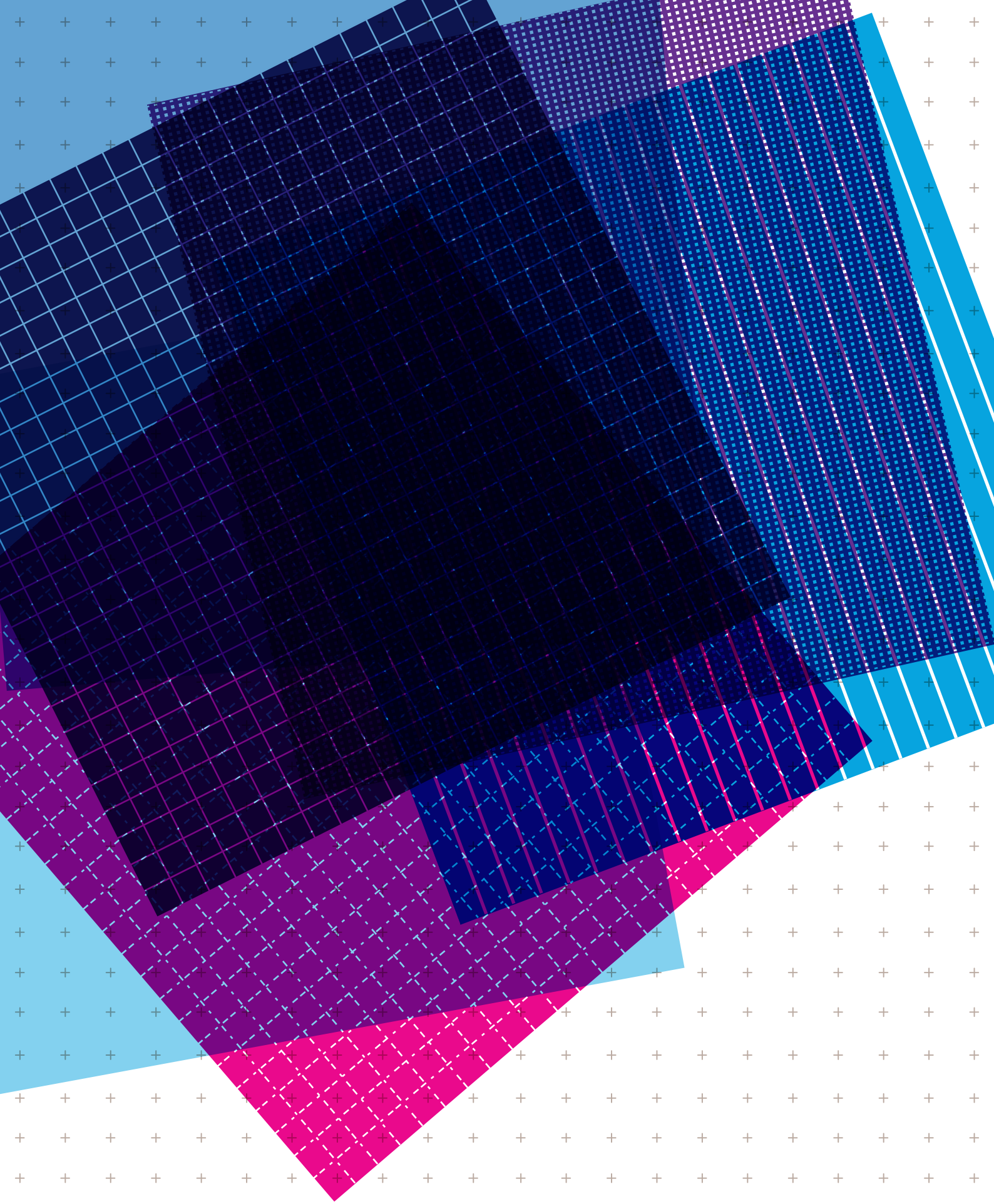
Notes



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