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Current Issues
Technology and innovation

The global race for excellence and skilled labour

A status report

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The race to boost skill levels and enhance academic excellence is in full swing: expenditures for higher education and for research and development are increasing sharply around the world – and especially in emerging economies.

Higher education is on an uptrend not only in developed countries but also worldwide: the share of the world population with tertiary educational attainment is increasing rapidly. Only sub-Saharan Africa shows relatively disappointing performance; too little has been done there – except in South Africa.

The positions of the individual BRIC nations in the race are mixed: Russia is a "nation of learning" which has had a lead on many developed economies for decades. Russia should step up its pace again, though, since China is rapidly catching up. Brazil and India are also showing improvements.

Industrial countries still hold the lead in the current dash to boost excellence: higher education systems are difficult to compare on account of data availability, yet an analysis of the "Shanghai rankings" shows that the industrial countries dominate the field in terms of the excellence of their higher education systems.

However, the emerging markets have joined the fray: the share of Chinese and Brazilian top universities has simply jumped since 2003.

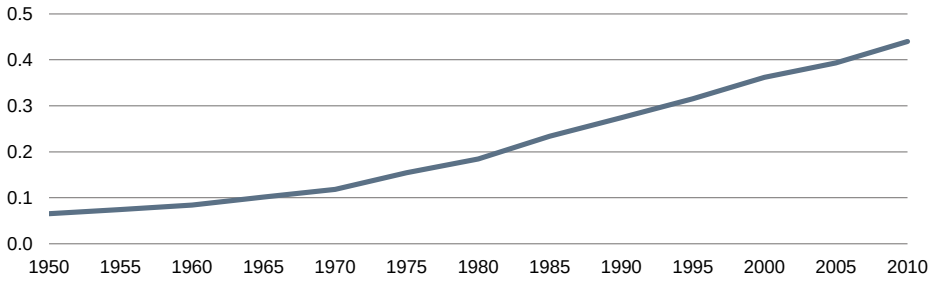
Excellence via investment in research universities: our analyses show there is a significantly positive correlation between expenditures on education and scores in the Shanghai ranking.

Germany poised to catch up: Germany trails comparably developed countries both in terms of spending on tertiary education and the share of tertiary educational attainment in the population. However, Germany produces more excellent universities than is to be expected from a statistical analysis.

A cross-border, project-economy approach to collaboration is a key factor in the dash to boost educational achievement: there is a need for cross-border projects, programmes and partnerships with aspiring institutions in other developed countries and emerging economies and for the creation of new possibilities to finance these initiatives in order to compete in the long-term race to produce more tertiary graduates and spur global progress in knowledge.

Global tertiary educational attainment increasing sharply 1

Average tertiary educational attainment (years, population over 15)



Weighted average of 146 countries

Sources: Barro & Lee (2011), DB Research

Higher education on an uptrend – (almost) all around the world

The race to boost skill levels and enhance academic excellence is in full swing: expenditures for tertiary education and for research and development are increasing sharply around the world – and especially in emerging economies.

As a result of the structural change towards more knowledge-intensive business activities in the developed economies, tertiary education on the one hand and research and development activities on the other are playing key roles as drivers of innovation. Without the much-cited skilled labour, companies cannot produce intelligent, innovative products. This is why countries worldwide are now fully engaged in a race for educational attainment and excellence in education systems.

Besides basic education, countries are placing their bets on higher education. And it is a good thing they are doing so, as statistical analyses show that higher investments in education and the promotion of tertiary education in particular are of great benefit to the economy: compared with a pure focus on the primary and secondary levels additional investment in tertiary education can generate good macroeconomic returns.[1]

Countries are thus increasingly competing with one another to find ways to establish, equip or better organise tertiary educational institutions – say, universities – in order to produce more knowledge, provide a good education and allow people – equipped with academic credentials – to further develop their own potential while at the same time building national advantages as a location for doing business.

In this context, higher education as well as research and development (R&D) have long since ceased to be purely the domain of the developed Western economies. Numerous regions of the world, some in the emerging markets in particular – the often-cited BRIC countries – are catching up in this segment.

In this report we shall attempt to determine systematic coordinates that define the development of knowledge, higher education and excellence of these efforts.

[1] See Barro and Lee (2011).

Human capital & tertiary education

Human capital refers to factors that are inextricably linked with individuals such as education, experience, competencies or personal motivation which, if deployed properly, have a positive impact on the growth potential of national economies and their productivity (Black/Lynch 1996).

In everyday life – and in this report as well – the term is often used as a synonym for education.

Measuring or comparing the stock of human capital as an aggregation of competencies and education of different individuals in different cultures and countries is difficult, if not virtually impossible, since there is often a dearth of reliable, historical data.

To be able to compare countries' scores nonetheless, we built a model based on the unique data set compiled by economics professors Robert J. Barro (Harvard University) and Jong-Wha Lee (Korea University) in the years 2010 and 2011. Taking "average educational attainment" as a reference enables us to compare countries in terms of the development of their higher education system.

Having analysed the development of this indicator in detail we present the mainly descriptive findings here.

Given the high degree of aggregation for these data, we refrain in most cases from making conclusive assessments and above all from stating reasons for given developments where this would not be justifiable.

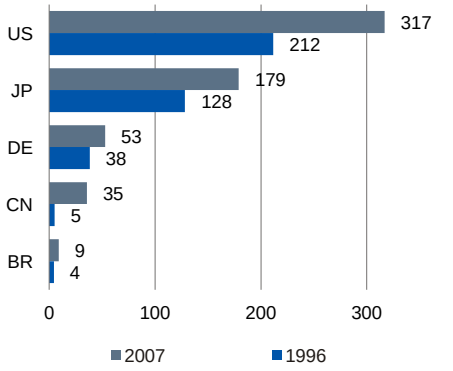
Tertiary education is the highest level in the formal education sector. It includes levels 5 & 6 of the most common ISCED definition.

ISCED stands for International Standard Classification of Education.

In Germany, the tertiary segment spans education at universities and universities of applied science (Fachhochschulen) (ISCED Level 5A) as well as colleges and vocational academies (ISCED Level 5B). Also considered part of tertiary education are master certificates in the trades (also ISCED 5B), as well as academic education leading to an advanced research qualification such as doctorate or PhD programmes (ISCED Level 6).

Investments in R&D 2

USD bn at constant prices (2007)



Source: World Bank WDI

Investment boom in education and research in emerging markets

Education and research – the production of knowledge and the imparting of knowledge – are inextricably linked with one another. Germany, in particular, boasts a long tradition embracing the unity of teaching and research. For this reason, a look at education efforts without including research and development activities would be incomplete. In the following we will therefore focus our attention on investment in research and development in various countries in order to establish the current state of the international race for knowledge and research expansion. And it is unmistakable: the developed countries remain heavyweights in terms of knowledge and research.

The United States invests the most in research and development by far: the total spent in 2007 was USD 397 bn. In Japan investment totalled USD 214 bn and in Germany some USD 63 bn in the same year.

The global race for excellence and skilled labour

Research expenditures 3

Gross, USD bn (2000)

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
US	212	224	236	253	272	276	271	277	279	291	303	317
JP	128	133	137	137	142	146	148	152	155	165	173	179
DE	38	40	41	44	47	47	48	48	48	49	51	53
CN	5	6	7	8	11	12	15	18	21	26	30	35
BR	4	0	0	0	7	7	7	6	6	7	8	9
IN	2	3	3	3	4	4	4	4	5	5	6	6
RU	2	2	2	2	3	3	4	4	4	4	4	5

Source: World Bank, World Development Indicators 2011

By comparison, R&D spending in the much-discussed BRIC countries remains low: USD 42 bn in China, USD 11 bn in Brazil and USD 7 bn in Russia.

However, the level alone only reflects one part of the overall picture. To put the figures into perspective it is important to capture the change in research efforts in particular. What emerges: the absolute spending figures have skyrocketed especially in China: up 615% since 1996. However, Brazil with its increase of 110%, India with 156% and Russia with no less than 106% suggest that the BRICs are also banking on growth via knowledge production.

A similar picture materialises when looking at the shares of R&D expenditure as a percentage of gross domestic product (GDP). The BRIC countries are catching up (China from 0.6% in 1996 to 1.4% in 2007, Brazil from 0.7% to 1.1%, Russia from 1% to 1.1% and India from 0.6% to 0.8%). However, R&D spending in the BRICs still trails far behind the readings in the major industrial nations. For instance, the ratio of R&D investment to GDP in 2007 in the US was 2.7%, in Japan 3.4% and Germany 2.5%.

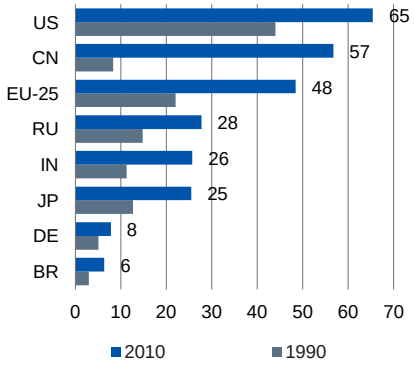
The competition for knowledge is intensifying. And the R&D investments in the BRIC countries are already showing results. China in particular is producing more patents, i.e. protected, valuable knowledge.[2] India and Brazil are also active on the patents front.[3] Only Russia is losing ground at the moment in terms of patented knowledge.[4] However, it can be seen that also with regard to patents – despite the growth in the BRIC countries – the industrial nations remain undisputed leaders in their role as innovation drivers: 28% of all global patent applications filed are from the US, 17% from Japan and 15% from Germany.

Yet knowledge production via research is only one side of the coin. To be able to conduct research, to produce new knowledge via a recombination of existing knowledge or via creativity, one must educate and train people first. It is for this reason that international competition in the area of higher education, in the tertiary segment in particular, is increasing. The role of universities as research and education institutions and the role of their graduates as innovators are gaining importance in the light of a global knowledge economy. But what is the current state of play in the global race?

[2] China boosted its share of global patent filings from 0.3% to 3.5% between 1996 and 2007.
[3] In the 1996 to 2007 period India increased its share of global patent filings from 0.1% to 0.7%, and Brazil from 0.1% to 0.3%.
[4] The Russian share of global patent filings fell slightly from 0.5% to 0.4% in the years 1996 through 2007.

Largest population with higher education: US 4

People with tertiary degrees (million)



Sources: Barro & Lee (2011), DB Research

More and more people with tertiary education …

The US is home to the largest population with a completed tertiary education. In 2010, roughly 65 million people in the US held a university degree or had an equivalent education. Next in line was China with 57 million. Note, though, that China's population of highly educated has ballooned by over 700% since 1990 on account of government investment in education. Looking at Russia and India: the highly educated population has, since 1990, slightly less than doubled (RU) and slightly more than doubled (IN), respectively.

Number of academics 5

	1990	2010
Brazil	2,996,584	6,392,672
Germany	5,065,932	7,805,163
Japan	12,701,808	25,483,310
India	11,313,015	25,701,325
Russian Federation	14,813,760	27,726,426
EU-25	22,078,439	48,426,744
China	8,354,300	56,716,036
USA	43,989,440	65,410,920

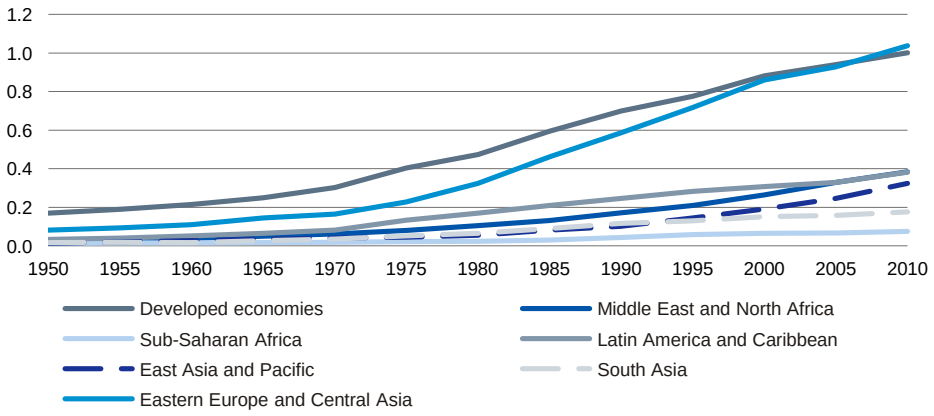
Sources: Barro & Lee (2011), DB Research

… and average tertiary educational attainment has been increasing sharply since 1950

A measure often used to compare countries and ascertain the population's tertiary educational attainment level is the average number of years spent by the population in tertiary educational institutions. This indicator has developed impressively over the past 60 years: while an average citizen of a developed country[5] had 0.2 years of higher education on average in 1950, this reading had increased fivefold to one year by 2010. A similar trend is also to be observed in many developing countries and emerging markets (see chart 6). Eastern Europe and Central Asia in particular are counting on the benefits of tertiary education. Unfortunately, the weakest performance is to be seen in sub-Saharan Africa.

Tertiary educational attainment increasing strongly worldwide 6

Tertiary educational attainment (years, population over 15)

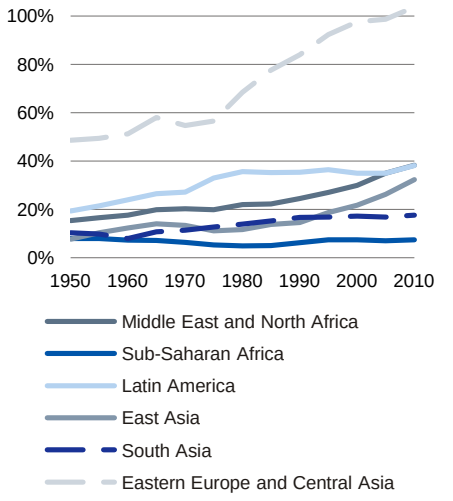


Sources: Barro & Lee (2011), DB Research

[5] Barro & Lee (2011) regard the following entities as developed economies: the EU-15, the US, Canada, Switzerland, Norway, Iceland, Turkey, Australia, New Zealand and Japan.

Rest of world narrowing the educational gap 7

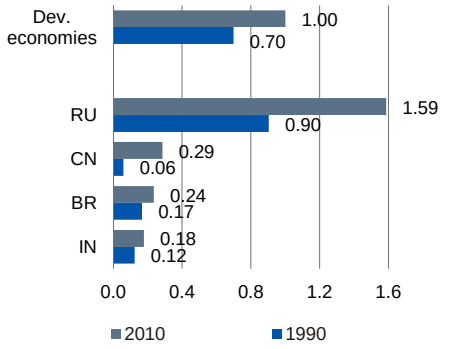
Tertiary educational attainment share in developed economies (%)



Sources: Barro & Lee (2011), DB Research

BRICs and tertiary education: A mixed picture 8

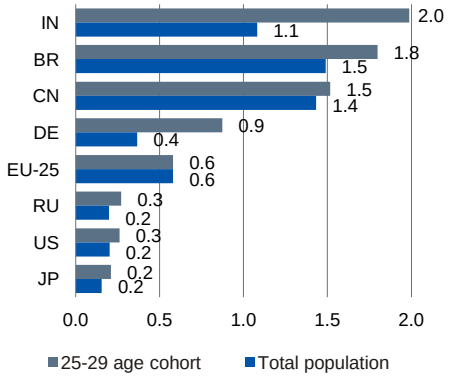
Duration of tertiary education (years)



Source: Barro & Lee (2011)

Younger generations: More educated 9

Duration of tertiary education (years), 2005



Sources: Barro & Lee (2011), DB Research

All world regions stepping up efforts in terms of education – except sub-Saharan Africa

All countries are stepping up their efforts in terms of education; the relative gap, i.e. tertiary educational attainment as a percentage of total education attainment in the developed economies, has been narrowed in most regions of the world (see chart 7). Eastern Europe and Central Asia in fact pulled slightly ahead of the industrial nations in 2010, since their populations had continually aspired to achieve a higher education since 1980 – albeit the ramifications of various systemic transitions throughout these regions made the going tough. In Latin America as well as the Middle East and North Africa this trend towards more education did not emerge noticeably until after the turn of the millennium, just like in the countries of East Asia. The only inglorious exception to the globally positive development is sub-Saharan Africa. This region – with the exception of South Africa – has managed to close the gap in tertiary educational attainment a bit since 1980, yet remains *the* developing region in terms of education.

Are the BRIC countries catching up? Yes, ...

As far as the BRIC countries are concerned, a very mixed, interesting picture of the field emerges in the race for more education: in 2010, for example, Russia, with its roughly 1.6 years of tertiary education on average, has noticeably outstripped the average of the developed economies ever since the mid-1980s. In fact, since 1990 Russia has even managed to extend its lead.

While China clearly trails the developed countries in terms of tertiary educational attainment (at an average of 0.29 years), it has boosted this average by 383% over the past 20 years. This means that China is still far behind the leaders, but it is narrowing the gap. Second place in the BRIC "chasing group" is shared by Brazil and India. In these countries the growth of tertiary educational attainment roughly equalled the level in the developed countries: in other words, these two countries have not quite closed the gap to the group of industrial countries.

… young people in particular are banking on education!

In order to correctly analyse trends in the education sector it is advisable to focus especially on the interest shown in education by the younger cohorts of the population. After all, people usually obtain a tertiary education when they are young – if all goes according to plan, the tertiary education phase should initially be over by the time they are 25. Subsequently, tertiary educational attainment increases only as an exception, not as a rule.[6] So the 25-29 age cohort is of particular interest for our analysis. The trend towards greater tertiary education observed is very pronounced in this age cohort (see chart 9): in all the major economies covered – except Germany – the education attainment reading for the 25-29 cohort is higher than for the population in total. The younger generation has a higher education particularly in the EU-25 countries and in Japan.

Since it is especially in developed countries that younger people have much more schooling – tertiary educational attainment is sharply rising also among the 25-29 age cohort in developed economies – there are no visible signs of this group in the BRIC countries catching up to the average of the developed economies.[7]

[6] This is where gaps emerge in the statistics on the development of human capital, since so far activities to upgrade people's education and training – the whole field of continuous education and training & lifelong learning — have actually not been duly captured. This means all conclusions are to be approached with caution.

[7] The picture differs widely as regards primary and secondary education.

Education is a hot trend worldwide – but how about excellence?

Average tertiary educational attainment is increasing sharply in virtually every region of the world. Convergence in the area of tertiary educational attainment is to be seen between the developed economies and the countries of Eastern Europe, Central Asia and East Asia in particular. But what do these figures say about the development of the quality of education? Unfortunately: not a thing! The quality of education is reflected neither in the data of Professors Barro and Lee, nor in other data sets.

However, to be able to comment nonetheless on the current standings in the race for academic excellence that without question is underway – going by the reports published in relevant journals such as the *Chronicle of Higher Education* – we shall attempt to gain insights into the development of excellence in the university systems in the developed economies and the BRIC countries by taking recourse to the ARWU university rankings.

The whole world is striving for academic excellence

To compare the excellence of individual universities as part of national university systems, experts have in recent years increasingly focused on university rankings. These rankings cover only a small minority of the universities worldwide, however.[8] Nevertheless, these rankings are one of the few ways and indicators that can be used to compare various countries and their focus. One of the most influential ranking is the ARWU – also known as the Shanghai ranking.

Top-ranked universities in the ARWU 10

Top 5 worldwide
1. Harvard University
2. Stanford University
3. Massachusetts Institute of Technology
4. UC Berkeley
5. University of Cambridge

Top-ranked university in Europe
University of Cambridge (5)

... in continental Europe
Swiss Federal Institute of Technology Zurich (23)

... Germany
Technical University Munich (47)

... Russia
Moscow State University (77)

... Brazil
University of Sao Paulo (129)

... China
Tsinghua University, Beijing (195)

... India
Indian Institute of Science, Bangalore (314)

Source: ARWU 2011

The ARWU ranking

The Academic Ranking of World Universities was first published in 2003 by Shanghai's Jiao Tong University.

Since 2003, presumably the world's top 500 universities have been analysed and ranked on the basis of six objective indicators.

The indicators and their weighting (in %) are:

i. Number of alumni and staff winning prizes (10%)
ii. Number of staff researchers winning prizes (20%)
iii. Number of highly cited researchers (20%)
iv. Number of articles published in the leading journals *Science* and *Nature* (20%)
v. Number of articles in the Science Citation Index Expanded and Social Sciences Citation Index (20%)
vi. Per capita performance with respect to the size of an institution (10%).

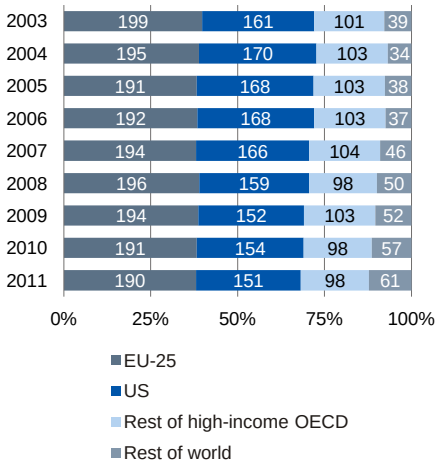
The ranking is regularly the object of criticism: it is said to be too backward looking, to favour natural sciences over social sciences and to neglect national characteristics.

Nevertheless, ARWU is one of the few benchmarks that enable the making of relatively objective and aggregated comparisons of the performance of various universities in different countries.

[8] According to Webometrics – a ranking based on web indicators – there are 19,403 universities worldwide. Of this number only slightly over 1,000 are considered in the ARWU. Only the top 500 are contained in the ranking published.

Rich countries dominate ARWU 11

Universities in the ARWU top 500



Sources: ARWU 2003-2011, DB Research

Excellence: Developed countries are predominant

There are universities from 43 different countries to be found in the top 500 of ARWU. The ARWU is clearly dominated by universities from several developed economies. In 2003, about 395 of the top 500 universities in the global ranking were to be found in the EU-25, the US and Japan. If the rest of the countries classified by the World Bank as "high-income OECD"[9] are included, the total comes to 461 of 500 universities in 2003.

The share of the developed countries has been falling since 2006, though. In 2011 there were only 363 universities still in the ranking from the US, EU-25 and Japan, or 439 from the high-income OECD countries.

In our opinion, this decline is not due to less excellence among the universities in the developed countries. Rather, the intensified global competition for more excellent research, top researchers and students is leading to more excellence – and this also applies to some of the emerging markets.

East Asia: Academic performance on the rise …

Regionally, there has been a strong upswing in performance since 2003 in East Asia in particular. While there were still only 29 East Asian universities in the ARWU ranking in 2003, there were already 49 by 2011. Most of the increase is attributable to China.

... Latin America and the Middle East are closing in

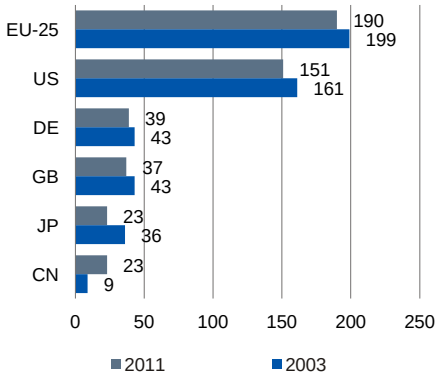
In Latin America the number of top universities inched up from 7 to 11 from 2003 to 2011, in the Middle East and North Africa from 6 to 11. This increase in the peripheral regions came mainly at the expense of the developed economies, whose representation in the ranking is slightly declining.

Less excellence in sub-Saharan Africa

A very low-level negative trend is to be observed for the sub-Saharan Africa region. In this area, the number of ARWU top 500 universities has decreased from 4 to 3 since 2003 (all 3 universities are in South Africa). This negative trend chimes with the stagnation observed in tertiary educational attainment for the population as a whole. Sub-Saharan Africa thus remains a problem area in terms of the development of human capital, even if the trends in the primary and secondary education sectors are slowly improving a bit.[10]

ARWU top 500: US & EU-25 undisputed leaders 12

Number of universities in ARWU top 500



Source: ARWU 2003-2011

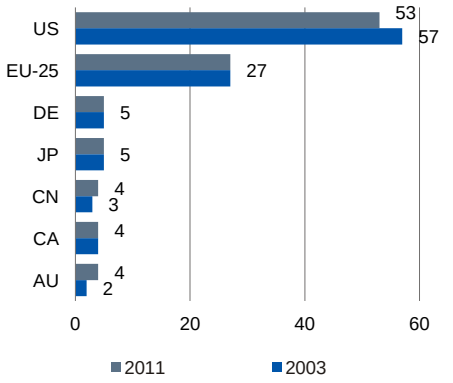
Academic excellence: The US is undisputedly the leader

151 of the world's top universities were to be found in the US in 2011[11] – and the higher in the ranking the group of universities observed, the more impressive the dominance of US institutions: 53 of the ARWU top 100, 34 of the ARWU top 50 and 17 of the ARWU top 20 universities are located in the United States. This is partly attributable to the academic culture, the professionalism and the (hitherto) good funding base of most of the US universities with a mixture of donations, income from tuition fees, grants from the state and the opportunity of

[9] EU-25 (excluding LT, LV, MT, CY), IS, CH, NO, CA, US, AU, NZ, IL, KR, JP.
[10] See Rollwagen/Renkin (2011) and Barro-Lee 2010.
[11] However, this does not allow any statement on the quality of the overall US higher education system. There is a very large number of US universities in the leading group. But across the breadth of the higher education system there are major challenges to be met especially in the US at the so-called Community Colleges and also other colleges, as regards their graduate rates, for instance.

ARWU top 100: Most top universities in the US 13

Number of universities in ARWU top 100



Source: ARWU 2003-2011

higher education institutions to refinance expansion endeavours via the capital market.

Europe, a traditional seat of learning, trails at a distance

"Old Europe" with its traditional universities follows at a respectful distance, but these are making major progress in efforts to narrow the gap. Germany, the nation of poets and philosophers, is the best-represented country with 39 universities in the ARWU top 500. The United Kingdom is represented with 36 universities, with the prestigious traditional universities of Cambridge and Oxford in leading positions.

The entire EU-25 had 189 universities in the ARWU top 500 in 2011 and thus led the US by 38 institutions.

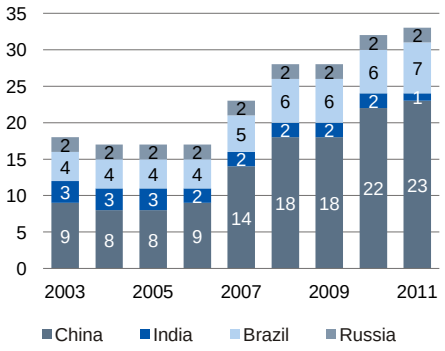
Looking at the ARWU top 100 universities, Europe is unable to match the US performance, though: in this group there are 27 universities from the EU-25 (26 universities less than from the US), without anything having changed on this score since 2003.

China catching up …

A country's current ranking in the race for academic excellence is important. But, here too, it is advisable to analyse developments over time: China and Brazil have advanced strongly in the ARWU over the past eight years. In China, the number of universities in the ARWU top 500 has more than doubled since 2003, from 9 to 23.

Top universities in the BRIC countries 14

Number of universities in ARWU top 500



Source: ARWU 2003-2011

... and Brazil is making good progress …

Brazil also saw a sharp increase in the number of its top universities, from 4 to 7, during this period. China and Brazil thus account for more than 50% of the ARWU top universities outside the high-income OECD countries. However, so far at least, none of the universities from these two countries has managed to advance to the ARWU top 100.

… while Russia is stagnating …

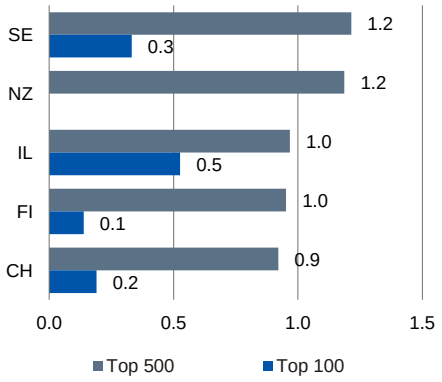
Russia has kept its share in the ARWU constant since 2003 at two institutions. Besides, Russia is the only BRIC country with one of its universities (Moscow State University) listed among the ARWU top 100. Nevertheless, Russia's score is relatively disappointing: unlike the other BRICs, Russia has had an admirably well-educated population for decades – in the primary, secondary and also in the tertiary segment. Despite better prerequisites than other emerging markets Russia has not succeeded in expanding its position in the top category internationally. This could be partly related to the challenges linked with the systemic transformation in that country as well as the emigration of many of Russia's young academic talents who initially go abroad – partly and mainly to the US, but also to Germany – in order to pursue an academic career there.

… and India is struggling with problems

India also has to struggle to hold its own or narrow the gap in the race for academic excellence. In contrast to the positive trends of the other BRIC countries, two of the three Indian universities formerly in the ARWU top 500 have fallen out of the ranking. India now only has one ARWU top 500 university, the "Indian Institute of Science". This partly reflects the challenges facing the subcontinent of India in its various states in respect of appropriate regulation

ARWU - top universities relative to inhabitants 15

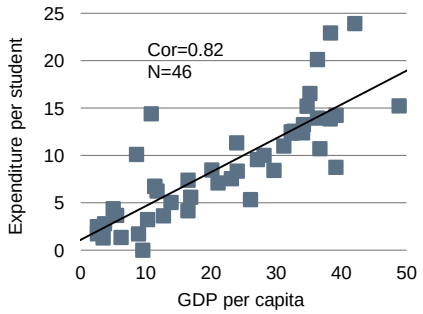
Top universities per million inhabitants, 2011



Source: ARWU 2011

Rich countries invest more in tertiary education 16

Average for 2002-2008 (USD '000)



Sources: OECD, Penn World Tables

and adequate funding of research and higher education. The appropriate remuneration of talented academic personnel, the implementation of quality management systems in university management, more public-private projects and the incorporation of companies and sponsors would be beneficial.

The dash for excellence – another case of small but packing a big punch!

While large industrial countries in particular appear to score well in the ARWU ranking, small, rich economies seem to be the most successful relative to their population size. At 1.2, Sweden had the highest ratio of ARWU top 500 universities to millions of inhabitants, followed by New Zealand (1.18), Switzerland (1.05), Israel (0.97) and Finland (0.95). Large countries such as the US (0.49), China (0.017) and the EU-25 as a bloc (0.3) trail far behind.

The tertiary education dash: Also an issue of funding?

While some countries are developing very positively in terms of both tertiary educational attainment and the excellence of their national universities, other countries are in some cases only slowly overcoming their unsatisfactory education levels. But what is driving these developments? Which factors determine the quantitative development – measured as the share of tertiary educational attainment in the population – and the qualitative development of excellence – measured in terms of the ARWU ranking?

In seeking to answer these questions we set up a Poisson model to observe the impact of expenditures for tertiary education in absolute terms and per student.

Explanatory note: Poisson model

A Poisson regression is usually used to model "count data", that is, only discrete variables with a value greater than or equal to 0. In doing so it is assumed that this variable has a Poisson distribution and therefore the mean is equal to the variance. If this assumption is violated, a somewhat more flexible model based on the negative binomial distribution is used. In our case, following tests based on Cameron and Trivedi (1990) and Wooldridge (1997), the assumption of overdispersion can be rejected. Additional estimates of a NegBin model reveal no major differences in the results.

The coefficients of a Poisson model cannot be interpreted as a constant marginal effect. Given the log-linear form of the model the marginal effect of additional spending depends not only on the level of spending but also on the size of the population and per capita GDP. Additional spending for tertiary education would therefore have less of an impact in a large, rich country than in small, poor countries. Usually, other goodness-of-fit indicators (R^2) are used for Poisson regressions than for conventional ordinary least square (OLS) estimators. We use 3 indicators here, namely:

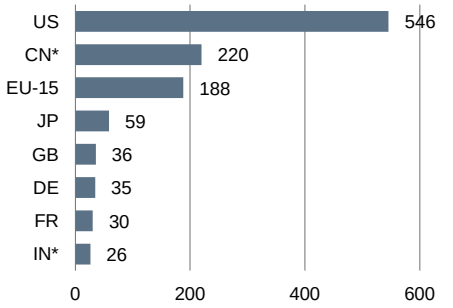
$R^2(1)=CORR(y,\hat{y})^2$

$R^2(2)= 1 – \log L(y) / \log L(\bar{y})$

$R^2(3)=$ Deviance-based according to Cameron & Windmeijer (1995)

US is top spender on tertiary education as a whole ... 17

USD bn, 2008



*India: Data from 2002; China: DB Research estimate

Sources: OECD, DB Research

Who spends how much on tertiary education?

In absolute figures, the US spends the most money for higher education by far. Spending on tertiary education totalled USD 545 bn in the US in 2008, followed by China at approximately USD 220 bn. The expenditures in the EU-15, at USD 188 bn, scarcely came to one-third of the US figure in 2008.

"Rich countries, high expenditure per student" …

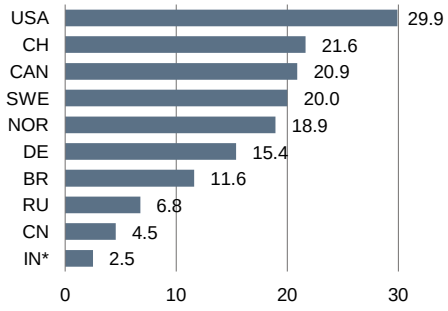
Not surprisingly, rich countries spend the most – per student – on tertiary education. The correlation between expenditure per student and GDP per capita is extraordinarily high at 0.82. Even among the rich countries, the US is quite clearly the top spender on tertiary education with expenditures of about USD 29,900 per student. It is followed by Switzerland (USD 21,600) and Canada (20,900). At USD 15,400, Germany lags far behind the leaders yet is significantly above the OECD average of USD 11,620.

… the BRIC countries still far behind – except for Brazil

Brazil is nearly spot on the OECD average at USD 11,610. Russia and China fall far short of this average at USD 6,760 and USD 4,550 respectively. This shows that especially in Russia and China a great deal more can be invested in education in future.

... and per student 18

USD '000, 2008



*Data for India from 2002

Sources: OECD EAAG 2005-2011

China investing in excellence …

The good scores achieved by many Chinese universities in the ARWU ranking are all the more astounding – this may possibly indicate a sharply uneven allocation of the funds available to the Chinese universities as well as extremely strategic fund allocation and use on the part of several Chinese universities.

… India will most probably have to boost its input

Unfortunately, expenditure data for India are only available for the year 2002. Ten years ago, the average expenditure per student there ran to USD 2,500 and was thus far below the level in the OECD countries. So with its young society the densely populated subcontinent of India will probably have to invest more money in education in future if it entertains any hopes of holding its own or even outperforming in the global race for knowledge and education.

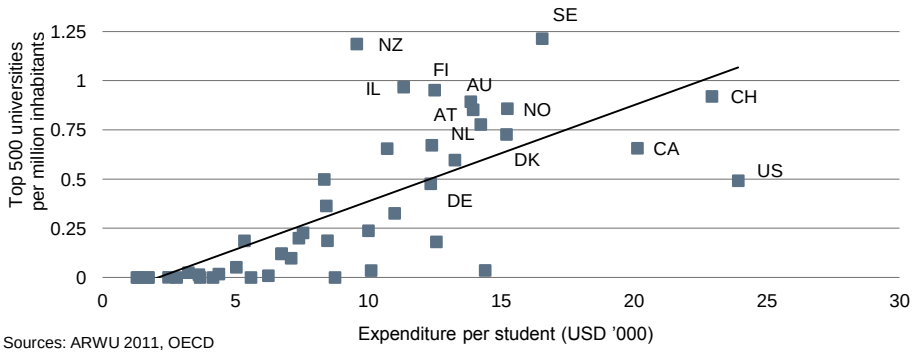
How does expenditure impact tertiary educational attainment?

But how does investment in education influence the outcome in the global race for educational attainment? Across several specifications and age cohorts (20-24 and 25-29 years) it emerges that neither average expenditure on tertiary education per capita nor per student have virtually any impact on tertiary educational attainment of a population in our random sample of 45 OECD members and partner countries, whether adjusted for R&D expenditure or not.

If GDP per capita remains constant, expenditures on tertiary education have no significant influence on the average duration of tertiary education.[12]

[12] It is interesting to note that regional dummy variables in some cases show significant and high coefficients – negative for Europe and positive for Anglo-American and Asian countries. We draw the conclusion from this that there is only a small correlation between expenditure and the average duration of tertiary education in our random sample, and this is mainly in connection with institutional and cultural factors as well as the level of a nation's wealth. Note in this context, however, that our sample contains only relatively well-developed countries – 30 OECD members and 15 partner countries – and that given a larger sample containing more developing countries

ARWU top universities and expenditures 19



Sources: ARWU 2011, OECD

Excellence – a question of funding?

But how does expenditure influence the score in the ARWU ranking? To quantify the significance of expenditures in the tertiary sector for the excellence of a country's tertiary education sector – with all the restrictions discussed – we set up a Poisson model. In doing so, we use the number of universities in the ARWU top 500 as an endogenous variable. Our sample contains a total of 45 countries, consisting of OECD members and several partner countries in which 480 of the ARWU top 500 universities are found.

Our relatively simple model can explain over 90% of the variation in universities in the ARWU top 500 per country using merely three variables: a country's population, per capita GDP and education expenditure per student in the tertiary education sector. As data on tertiary education expenditure is in some cases incomplete we use the average amount of expenditure for the years 2002 through 2007, including expenditures for teaching and research.

Model: Determinants of success in ARWU 20

Poisson model; dependent variable: top 500 universities, 2011, 45 observations; Huber/White standard errors

Var	Coeff.	Std. error	p-val.
Constant	-29.110	1.180	0.000
ln(POP)	0.731	0.039	0.000
ln(EXP)	0.652	0.185	0.005
ln(PCGDP)	1.250	0.182	0.000
R^2 (1)		0.965	
R^2 (2)		0.935	
R^2 (3)		0.834	
Std. error of regression		4.671	
Mean dependent var.		10.644	
Std. deviation of dependent var.		23.483	

Source: DB Research

Marginal effect … 21

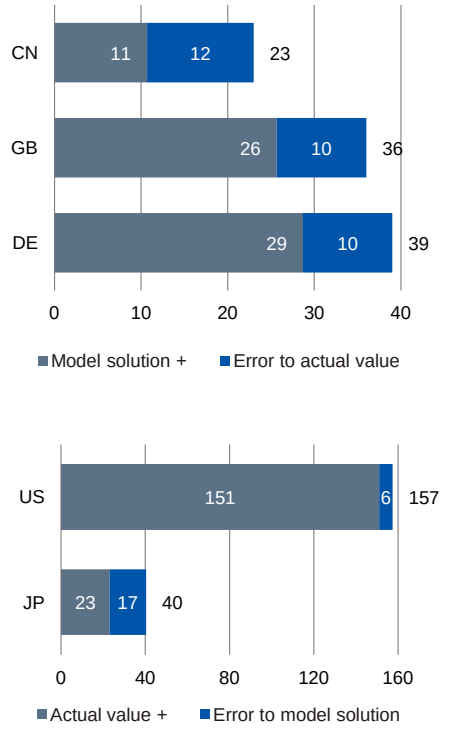
...of a USD 1,000 increase in expenditure on number of universities in ARWU top 500

Country	Expenditure (USD)	Marg. eff.
Germany	12789	1.4
France	11,438	1.2
United Kingdom	13,265	1.2
United States	23,931	4.3
Japan	12,900	2.0
China	4,465	1.5
Brazil	10,326	0.6
Russia	2,486	0.7
India	3,629	1.0

Source: DB Research

and emerging economies it might be possible to determine a significant effect. As there is little data available on education-related expenditure in the developing countries in particular, though, it is currently not possible to perform such an analysis.

Score in ARWU relative to GDP and expenditure on tertiary education 22



Sources: ARWU 2011. DB Research

Significant positive correlation between expenditure and excellence

Our model shows that expenditure on tertiary education is highly significant for maintaining a top ranking in the global dash for academic excellence as measured by the number of universities in the ARWU top 500. However, a major part of the variation between countries can already be explained by the factors GDP per capita and population size. The marginal effect of additional expenditures decreases in our model as expenditures increase, but this also correlates positively with the size of the population and GDP per capita. So the hypothetical effect of higher spending per student would – assuming the same level of spending – be bigger in a large, rich country than in a small, poor one. To illustrate the findings of our model we perform a thought experiment for several countries in which we calculate the marginal effect of a USD 1,000 increase in expenditure per student on the number of universities in the ARWU top 500.

According to our model, a hypothetical USD 1,000 increase in expenditure per student in Germany would have an effect of adding 1.4 (German) universities to the ARWU top 500. In the US the marginal effect would be the highest on account of the high per capita GDP and the large population, and would elevate 4.3 universities into the ARWU top 500. With the same funding increase China would only manage to add 1.5 universities to the ARWU top 500 ranking, and Brazil 0.6 universities.

Performance estimates in the dash for academic excellence

On the basis of the estimated statistical correlation we take the number of ARWU top 500 universities forecast by our model for each country and calculate the difference to the actual data in the ranking. Using these residuals it is possible to analyse which countries have more universities in the ARWU top 500 than are to be expected relative to the funds they spend on tertiary education, GDP per capita and the size of the population. The (positive) difference to the model results could be regarded – apart from other possible explanations – as an indicator of efficient funding allocation and the focus on excellence of a tertiary education system.

Germany scores well in relation to expenditure …

It emerges that China is clearly the leader in this category: whereas our model would explain the presence of 11 Chinese universities in the ARWU top 500, there are in fact 23. One possible reason for this may be the marked differences in per capita GDP across China and a possibly very uneven allocation of funding among China's universities. Some universities enjoy very strategically targeted support from the respective provincial government as well as national bodies; besides, they have more global research contacts and third-party funding which enable them to achieve higher levels of excellence faster than other universities in China.

Other countries that also far outperform our model solution are: the United Kingdom (+10), Germany (+10), Italy (+6) and Australia (+5). It is precisely in the case of the United Kingdom, Germany and Italy that path dependence might be at work. All the nations cited above have a history of academic traditions that dates back centuries. They are birthplaces of the university idea. This path dependence is also evident in Australia, since this country established its own university tradition on the basis of British influences over the past several decades via, for example, the export of university education to other parts of the world and forward-looking forms of student financing (income-contingent student

loans repayment terms for academics), thus enabling universities to expand on the basis of more diversified funding streams.

… the US scores less well on the whole, but is geared to excellence …

Despite the dominance of the US in the ARWU ranking it is interesting that the US has six fewer ARWU top 500 universities than the model predicts on the basis of per capita GDP, population and expenditure on tertiary education. However, more than one-third of America's universities rank among the ARWU top 100, so the US has its sights set on competing for top positions – i.e. global excellence in the global race for knowledge-based progress.

… just like Switzerland ...

In the case of Switzerland, a similarly strong focus on elite institutions is also one of the possible explanations for deviations from our model solutions. The total number of Swiss universities in the ARWU top 500 falls far short of the readings to be expected on the basis of expenditures and GDP. However, more than half of the Swiss institutions in the ranking are among the ARWU top 100. So Switzerland focuses on excellence and not the broad brush or better egalitarian approach as in Germany. By comparison: only one-sixth of Germany's universities make it into the ARWU top 100; at the same time, Germany has more universities in the ARWU top 500 than the model would suggest.

… and Japan is among the laggards

Japan in particular appears to be falling behind in the global dash for academic excellence. According to our model, Japan should sport 40 universities in the ARWU top 500 ranking. There are, however, only 23 Japanese universities in the ARWU top 500. This is particularly striking since Japan still had more than 36 universities in the 2003 ranking. The Japanese share has fallen sharply since 2003, however.

Challenges in the global dash for excellence and skilled labour

Since 1950, the number of people with access to tertiary education has skyrocketed, both in the developed economies and in numerous developing countries and emerging markets. Moreover, a great number of countries and world regions are converging – albeit in some cases slowly – with the level of the developed economies.

As regards the quality of education, too, countries such as China and Brazil are narrowing the gap to the West. Nevertheless, most of the emerging markets are still trailing relatively far behind. Focusing on elite education institutions in particular, there is still room for improvement in the BRIC countries. Sub-Saharan Africa remains the global problem area, as the provision of tertiary education persists at a low level there despite advances above all in the primary and, in some cases, the secondary sector.

The rise of the emerging markets is heralding a long-term increase in global competition also in knowledge-producing and knowledge-intensive segments, i.e. in research and development as well as in education. This will go hand in hand with increasing competition between national education institutions and education systems for the best minds, funds and ideas. The established tertiary

education systems in developed countries will have to face new challenges. New partners will have to be found, new alliances forged. This makes it seem all the more important to maintain and expand the prerequisites for tertiary education in these countries at both the top of the scale and across its breadth. In this context the focus is not only on funding but also on institutional reforms and capacities at existing institutions.[13] Furthermore, the foundations for tertiary education must be laid from the outset at the primary and secondary levels – here, too, there are many countries facing major challenges if they want to maintain their lead and seize comparative advantages.

The global development of tertiary education must be rated most positively – partly against the backdrop that education, and higher education in particular, offers individuals opportunities to realise their potential. And when education is closely integrated with research activities and the aspirations of innovative companies it is truly one of the key drivers of innovation and growth both in individual countries and around the world.

The only question is: what is the most promising strategy in a long-term perspective in the global race for skilled labour and excellence? A reasonable conclusion to be drawn for Germany is that its strategy of broad support in the quest for excellence has had its benefits. There are good reasons why Germany was the world's leading exporter for a long time on the basis of knowledge-intensive products and German engineering. There are good reasons that German researchers enjoy an excellent reputation worldwide.

Yet no doubt some things could be done in Germany, too, in respect of the funding of knowledge-based value-creation which may still be learned or adapted from top American institutions of excellence. For example, century bonds to finance academic infrastructures as issued by the Massachusetts Institute of Technology[14] are surely an idea that could be adapted to the needs of German universities and their sponsors (Germany's federal states). For without intelligent mechanisms to fund increasingly costly campus lecture halls and research buildings, laboratory capacities, scientific instruments and academic talents German universities will face a daunting task to succeed in keeping pace with the leaders in the global dash for academic excellence.

Furthermore, not only Germany but also the emerging markets will have to rely even more so than today on a cross-border, project-economy approach to collaboration on account of the dynamics in the tertiary education segment and the competition in R&D:[15] Cross-border projects, programmes and partnerships with aspiring institutions in other developed countries, emerging markets and companies as well as new instruments to support and fund these initiatives are required to meet the challenges in the race to expand higher education, to shape the global advances in knowledge with a view to greater sustainability and to pave the way for more people towards attaining more higher education and increasing their individual capabilities.

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[13] See Eurydice 2011.
[14] See Rollwagen 2011.
[15] See Rollwagen 2010.

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