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Innovative Capabilities and Market Performance: The European Union in International Comparison

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These topics form part of the pressing agenda of the EU and represent the multifaceted and complex nature of the European integration process. These papers also seek to highlight the internal and external dynamics which influence the workings of the EU and its relationship with the rest the world.

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Innovative Capabilities and Market Performance:
The European Union in International Comparison

Jan-Frederik Kremer and Katharina Below

This paper investigates the EU's international positioning in terms of innovative capabilities and global market performance by using most recent quantitative data on a wide branch of indicators. The EU's performance is compared to the standings of its most important economic competitors and emerging economic powerhouses: the USA, Japan, China, Brazil, India, Russia and South Africa. By doing so, this paper offer insightful and deep information about the EU's power to compete and rank in international economic affairs. It will be proofed that the European Union ranks in many of the indicators related to innovative capabilities in good position and the EU's overall global market performance is excellent, whereas the BRICS are underachieving.

Keywords: European Union, EU, Innovative Capabilities, Innovation, Power

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Introduction[1]

"Becoming an innovative country", "being an innovative entity", "staying innovative in a competitive environment"; phrases like those are on nearly every politician's lips when talking about innovation policy and the importance of innovation for the global standing of their political entity. In the last decade, there has been a real surge of strategy papers in the European Union (EU), official documents, think tank publications and policy outlines that stress the importance of knowledge, and innovation policy for the European Union's international rank in terms of economic competitiveness and political leverage. Already has the European Commission's (EC) Lisbon Strategy put a special emphasis on the significance of knowledge and innovation and the current Europe 2020 strategy (European Commission 2010a) stresses the importance of a knowledge and innovation based society for sustainable, long-lasting and enduring economic growth even more. Based on the finding, that innovation and knowledge are one, or maybe *the*, condition for economic growth and the power to compete in today's competitive international economic environment, the EU has set up a variety of support programs and funding lines to foster public knowledge infrastructure development, innovative capabilities, technological advancement and private innovation over the last years.[2] Obviously it can be considered highly important for a political entity/actor to know something about its comparative international standing in regard to its innovative capabilities and market performance in terms of the ability to compete. Thus, the aim of this paper is to deliver some answers on the question "Where does the EU stand in regard of her innovative capabilities and market performance in comparison to other industrialized and emerging political entities?"

Especially in the light of the ongoing debate of a (possible) power shift from traditional industrial countries to emerging powers, the question of the EU's international standing seems to be even more important. But this paper will not only be able to evaluate the EU's international standing in a comparative way, but it will also – as a kind of "side effect" – help us to understand if the status of the traditional industrialized countries is challenged by the emerging powers at all, by just some of them or in general.

It should be made clear, that the aim of this paper is not to develop a way out of the ongoing theoretical dispute on the general ontology of innovation, or to find a new theoretical path towards the understanding of the relation of power and innovation.

This paper is designed to investigate the EU's international positioning by using most recent quantitative data on different indicators, which the authors consider of crucial importance for the innovative capabilities and market performance of a political entity. The EU's performance in terms of its innovative capabilities and market performance will be compared to the standings of its most important economic competitors and emerging economic powerhouses: the USA, Japan, China, Brazil, India, Russia and

[1] The authors would like to thank Joaquin Roy, Astrid Boening, Maximilian Mayer and Jan-Paul Franken for their helpful comments and ideas, the most valuable assistance regarding the collection of data of Matthias Haget and Thomas Kuller is also most gratefully acknowledged. The authors also would like to appreciate the inspiration by Xuewu Gu and the Center for Global Studies' research group on "Rising Knowledge Power". Jan-Frederik Kremer also would like to express his thankfulness to the University of Miami and the European Union Center for the support during his stay as short-term visiting scholar.

[2] Most well-known the Framework Programmes for Research and Technological Development, but also smaller programs like the Programme for the Competitiveness of enterprises and SMEs (COSME) and the Innovation Union Strategy, cf.: European Commission 2005, 2006a; EC 1, 2, 3, 4, 5 and 6. For a more general overview about the EU's innovation/knowledge policy and their impact, see: Stajano 2009; Soriano and Mulatero 2010 and Muldur 2006.

South Africa. By doing so, this paper will offer insightful and deep information about the EU's power to compete and rank in international economic affairs for a wide range of indicators, based on latest data.
To do so, in a first step (chapter I) some general theoretical remarks on the importance of innovation and innovative capabilities for the international standing of an political actor/entity/state will be made, with a special focus on existing theoretical validations of the relevance of innovation for an entity's economic performance and intentional standing shared by the authors. Further, a working definition of innovative capabilities will be presented.
In a second step (chapter II), after some general remarks on the selection of the different indicators, the data on the EU's innovative capabilities and market performance will be presented and analyzed.
To conclude, the European Union ranks in many of the indicators related to innovative capabilities in good position and the EU's overall global market performance is excellent, whereas the BRICS are underachieving. Despite the challenges the EU faces today, it becomes obvious that the good standing of the EU is owed to the fact that the EU is regarded in its entirety, which should provide another argument for further European integration.

I. Innovation, Innovative Capabilities and their Importance for the International Standing of an Entity

Writing about the importance of knowledge and innovation for entities' competitiveness, economic performance and power positioning in global affairs has become immensely en vogue over the last years. Countless publications in scientific journals and magazines discuss and try to grasp the ontological character of knowledge and/or innovation, possible theoretical linkages between them and their influence on states' and/or entities' international economical and political performance.[3] Further, a body of literature in economics and development studies stresses the importance of states' knowledge and/or innovation capabilities for economic development and growth.[4] Most recently scholarly work in IR has once again refocused its activity prominently on the relations between states' (structural) power and knowledge:[5] some works argue for a strong link between knowledge and power (Paarlberg 2004); others question the general idea of a relationship of that kind (especially works of the critical school). In the 1980s Susan Strange showed already how states' power and knowledge are related and how knowledge affects states' structural power (Strange 1987 and 1988: 115-133). Or, as Grieco and Ikenberry put it: *"Nations-States emerged in the modern world within a competitive state system that rewarded governments that had access to a thriving economy. The power of the state has always been ultimately dependent on the wealth and productivity of the society of which it is a part*" (Ibd: 9) and this productivity and wealth has always been related to the innovative capabilities of the state's economy (Ibd: 9-14, see also Cantwell 2004). On the other hand, a different branch of scholars in IR has uncovered the theoretical relationship between the possession of specific rare and highly processed economic goods and political power (most prominently: Hirschman 1947 (1980), more recently Co 2012; Kremer 2011a; Norrlof 2010; Anderson et al. 2000), or on the effect of global asymmetries between states in terms of their technological endowment (Baldwin 1980; Nye and Keohane 2001; Pustovitovskij and Kremer 2012). In modern economic theories of trade and growth there is no doubt about the importance of the factors technology, knowledge and innovation for the competitiveness and economic power of a state (cf. Aghion

[3] See for example the publications by Castellacci and Archibugi 2008; Fischer 2011; Stehr 2001, that in one or the other ways try to address those questions and problems.
[4] See here exemplary: Hauque 1995; Stajano 2009; Frietsch and Schüller 2010; Fagerberg and Srholec 2008; Lall 1987; Fagerberg 1987 and 1988.
[5] Cf.: Mytelka 2000; CGS-Forschungsgruppe Wissensmacht 2011; Below et al. 2012.

and Howitt 1998; Sachs 2002; Trebilcock and Howse, 2012: chapter I, Grieco and Ikenberry 2003: chapter I and II). Although there are different points of view regarding the question of how to understand and explain this correlation on a theoretical level, most of the today's research agree that knowledge and innovation are of essential importance for the global standing and the economic performance of states and political entities like the EU and various studies in IR and economics have proven this relationship p.e. for the case of China's economic and political rise (p.e. Altenburg 2008).
Therefore this paper follows the basic assumption, that a good performance in terms of innovative capabilities - whereas *innovative capabilities* are defined as *those indicators in the areas of investment & human resources, infrastructure and research-productivity that can be identified as pre-conditional to gain and sustain competitiveness and leadership in technology and advanced products* - is the necessary but not sufficient condition for a superior global (market) performance and one important condition for power to compete.
Although we cannot claim that there is an undoubted universally valid theoretical causal relationship between innovative capabilities and market performance, the existing body of literature and illustrated examples of empirical research clearly show that the availability of certain innovative capabilities can be seen as the necessary but not sufficient condition for the supreme market performance of an entity.

II. Innovative Capabilities and Market Performance of the European Union

As shown above, the innovative capabilities of an entity are of essential importance for its power to compete and its international standing in today's interdependent and interconnected global economic and political environment. Therefore, also for the EU with its large single market and intensified political, economic and monetary integration among the member states (like the EMU, Fiscal Compact, CSDP, common trade policy etc.), the ability to gain and maintain innovative capabilities is of crucial importance. Without engaging in the still ongoing debate about the general quality of the EU's actorness, most of the recent research on the EU consents that at the latest after the Lisbon-Treaty the EU can be ascribed the status of actorness in international relations (Verola 2010; Woolcock 2010).[6] Article 47 of the Treaty on European Union (TEU) explicitly recognizes the legal personality of the European Union (EU) and the ability of the EU to conclude and negotiate international agreements in accordance with its external commitments, to become a member of international organizations and to join international conventions, which are undoubtedly attributes related to actorness in international law. For example, in the case of the EU's international trade policy and its engagement in the governance of international economic relations, there is wide consensus about the EU's state-like actorness among scholars (Woolcock 2010; Nottebaum 2011; Kremer 2011b; Meunier and Nicolaidis 2005; Meunier 2006, 2007). Therefore, this paper follows the vast majority of recent research on the actorness of the EU and emanates that the EU can be seen as a state-like actor in most of the sectors of international affairs. Considering the evident importance of the EU as state-like actor in various domains of international relations, an analysis of the EU's innovative capabilities and market performance seems not only justified, but necessary to assess Europe's standing in global economic affairs. Furthermore, considering the immense and exceedingly integrated single market and the overwhelming importance of the EU's internal market governance and regulation, as well as its growing importance in foreign affairs (trade policy, international climate/environmental governance etc.), once more it seems more than necessary to asses innovative

[6] Cf. for example: Bindi 2010 for a more general assessment of the EU's external activities in historical perspective; Edwards 2011; Hill and Smith (eds.) 2011 (edited volume on the hole branch of the EU's external activity); Smith 2008; Keukeleire and MacNaughtan 2008; EC 2007a, 2007b for the EC's position on the international importance of the EU's single market and its implications for the EU more generally).

capabilities and market performance on an European level (which most of the research, by sticking to the member states, does not). This task is done in this chapter, in which we look into the innovative capabilities of the EU and its market performance by using a wide set of indicators, as shown in table 1:

Table 1: Innovative Capabilities and Market Performance – Indicators

Innovative Capabilities	*Market Performance*
Investment & Human Capital:	Royalty and license fees balance
Public spending on education (% of GDP)	Forbes Global 2000
Public spending on education and expenses-population ratio	Merchandise trade performance
	Commercial serv. trade performance
School enrollment tertiary (% gross)	
Infrastructure:	
Fixed (wired) internet subscriptions	
Fixed broadband internet subscribers	
THE Top-200 global universities by quarter	
Research-Productivity:	
Scientific journal articles	
Citations	
Patents applications by country of origin	
Total Number of Patent Families by Country of Origin	

Innovative Capabilities of the European Union

As mentioned in chapter I, innovative capabilities are defined as those indicators in the areas of investment & human resources, infrastructure and research-productivity that can be identified as pre-conditional to gain and sustain competitiveness and leadership in technology and advanced products and in our understanding are the necessary but not sufficient condition for a superior global (market) performance as well as one important condition for the power to compete. In this part of the paper the innovative capabilities of the EU will be assessed.

Investment & Human Capital

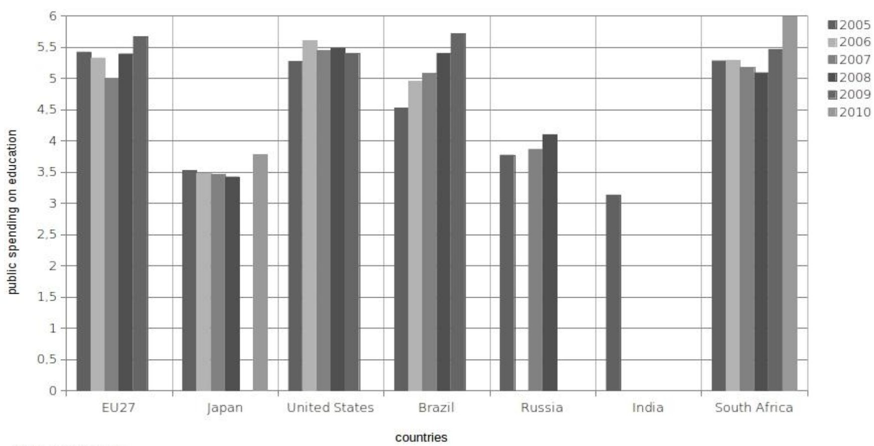
In this section indicators have been selected that give profound insight into the share of resources allocated to education and the overall amount of resources spend on education and the development of human resources. Of course, resources and money spent on education do not in every case translate into more innovation and higher competitiveness per se, but nevertheless multiple studies (cf. Lucas 1988; Barro 1991, 1997; Bassanini and Scarpetta 2001; Romer 1994; Pfeffer 1994; Temple 1999) have proved a statically correlation between investment in education/human capital and economic growth in gross national product (GNP), even though on a theoretical level a clear causal relationship is hard to establish. For example, literature in development studies and on economic growth, starting with neo-classical growth models, the so-called endogenous growth models (for example Aghion and Howitt 1998), which are still broadly used and current new-growth theories (that underline the importance of human capital for economic growth; cf. Nelson 2005, esp. 115-139) evidently show a correlation between public spending on education, the development of human resources and economic growth.[7] Altogether there is strong evidence that high expenditures on education (in comparison to other entities; p.e. measurable by Public Spending on education, absolute 2011 in billion € and expenses-population ratio) increase the economy's power to compete as well as its productivity and leads to a higher national growth rate (cf. for an overview Wilson and Brisco 2004). Therefore, spending on education and the availability of a well-trained and educated labor force large in numbers (measurable for example by using tertiary school enrollment rate) is apparently of huge importance for an entity's economic performance and it is necessary to examine it more closely.

Public Spending on education (% GDP)

EU efforts in public spending on education in upper-middle class, in terms of % of GDP. Pole position in public spending on education in absolute terms.

"Public spending on education" includes all spending for educational institutions (public and private) by the government and transfers/subsides for private entities (students, households etc.). Regarding public spending on education (% of GDP, see chart 1) the EU finds itself in an upper class position and leveled with the USA, Brazil and South Africa. Japan, Russia and India are well behind the leading group. For China, there is no consistent data form trustworthy international sources available; most of the literature on China's educational systems assumes a public spending rate on education of 4% (2010).

Chart 1: Public Spending on Education (% of GDP)



Source: Worldbank
Note: Public expenditure on education as % of GDP is the total public expenditure (current and capital) on education expressed as a percentage of the Gross Domestic Product (GDP) in a given year. Public expenditure on education includes government spending on educational institutions (both public and private), education administration, and transfers/subsidies for private entities (students/households and other privates entities).**No data avaiable for China.**

Consequently in terms of public spending on education in % of the GDP the EU is well positioned internationally and accomplishes one requirement for maintaining a superior educational system, even though there are huge differences between the member states (p.e. for 2009: Finland 6.8%, France 5.9%, Germany 4.6%, Spain 5.0%, Italy 4.7%, Poland 5.1%, Portugal 5.8%).

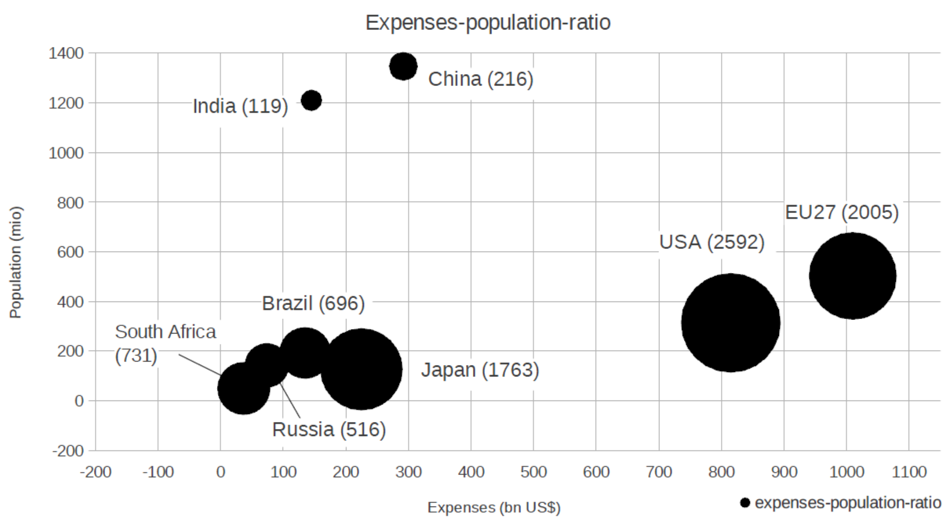
[7] Sylwester 2000 p.e. has shown that today's public spending on education is related to future economic growth.

Public Spending on education, absolute 2011 in billion € and expenses-population ratio

EU and USA superior. Japan in good position. BRICS doing poor.

It is not sufficient for one actor, in ordr to catch up with the leading political entities in education, to spend a higher, respectively at least equal number of resources (in regard to % of GDP) on education. Instead, it is necessary to spend (in comparison to other entities) a comparable amount of money on education in relation to the population size. That's why the authors have developed a more sophisticated indicator, the public spending on education expenses-population ratio (chart 2), to assess the standing in matter of measuring the resources allocated to the educational system.
The public spending on education expenses-population ratio indicates the virtual amount of money that the respective governments spend per capita on education in one year (in US$, 2010). As we can learn from chart 2, the absolute top-spenders for educational purposes with a huge advance, both in terms of the absolute amount of money spent (USA: ap. 815bn$ p.a., EU: ap. 1010bn$ p.a.), and in terms of the more important indicator, the virtual amount of money spent per capita (USA: 2592$ p.a., EU: 2005$ p.a.), are the USA and EU.

Chart 2: Public Spending on education, absolute 2011 in billion € and expenses-population ratio



Source: World Bank, CIA Factbook and IMF
Note: No reliable data for China. Expenses in nominal US$ (2010). All data has been rounded in steps of five billion €. The expenses/population ratio is the outcome of the money spend on education divided by the population. The public spending on education expenses-population ratio therefore indicates the virtual amount of money that the respective government spend per capita on education in one year (in US$, 2010).

In the light of the fact, to catch-up with the front row's entities the absolute amount of money and the virtual amount of money spent per capita matters, the only other entity, which can also be considered to be in good position is Japan (225bn$ p.a.; 1763 per capita). China and India underachieve visibly in both categories (China: 292bn$ p.a. / 216$ per capita; India 145bn$ p.a. / 119$ per capita), whereas Brazil, Russia and South Africa find themselves in mid-field positions with still a lot of air left between them and the US, EU and Japan.

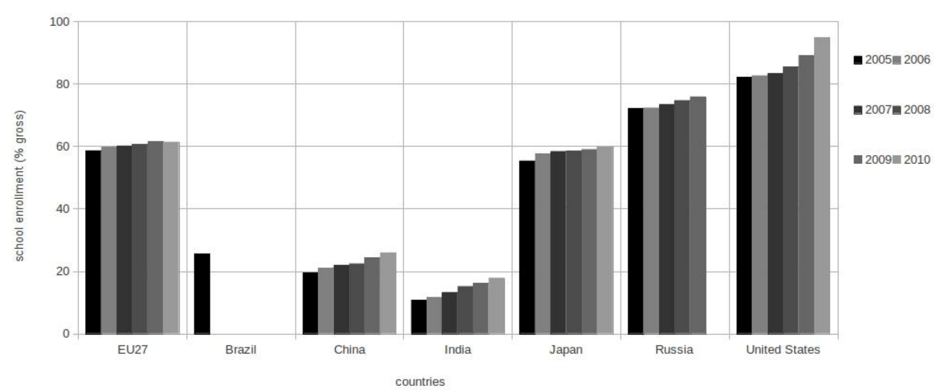
To sum up, in terms of resources allocated to the educational system, the EU can be ranked second and is in a good position, but additional efforts are needed in order to uphold this leading position and to close-up to the USA.

School enrollment tertiary (% gross)

USA: Highest enrollment rates (% gross), Russia, EU and Japan do well. Brazil, China and India catch up slowly.

As outlined above the formation and development of advanced human capital is another factor that is important for economic growth and international competitiveness of political entities. Numerous studies stress the importance of a well-trained and educated labor force for acquiring and effectively organizing the use of complex knowledge and skills, respectively economic growth in general (cf. p.e. Castellacci and Archibugi 2008: 1661; Cohen and Soto 2007; Barro 2001: 14-16). Like Barro (2001: 14) puts it: "*…more human capital facilitates the absorption of superior technologies from leading countries"* and therefore is one pre-condition for economic growth. The enrollment rate in tertiary education (International Standard Classification of Education category 5 and 6) is a useful indicator to measure the development and availability of human capital. As the data indicates, the EU and Japan take mid-field positions in regard to the tertiary school enrollment rate, whereas the USA and Russia occupy the top-positions and India, China and Brazil perform poorly.

Chart 3: School enrollment tertiary (% gross)



Source: Worldbank/UNESCO Institute for Statistics
Note: Gross enrolment ratio. Tertiary (ISCED 5 and 6). Total is the total enrollment in tertiary education (ISCED 5 and 6), regardless of age, expressed as a percentage of the total population of the five-year age group following on from secondary school leaving.

The very high rate of tertiary school enrollment in the US and Russia has to be understood in the light of entirely different systems of vocational education in those countries and most of the EU's member states (like Germany, France, Austria, Denmark Slovenia and the Netherlands): Whereas for example in the USA most of the vocational training is situated at community colleges, undergraduate university programs and adult education centers, that are classified as higher education level ISCED-5, a good number of the vocational training in Europe (but also in China) is done by institutions like the dual education system, which are not leveled ISCED-5 or 6, but deliver at least the same quality of education. Therefore, the mid-field position of the European Union in terms of tertiary education enrollment does not necessarily offer precise information about the EU's more general performance in human capital development and formation. Taking into account these differences, the EU finds itself in a good ranking regarding its availability and development of advanced human capital.

Summary "Investment & Human Capital": In all three indicators (public spending on education (% of GDP); public spending on education and expenses-population ratio; school enrollment tertiary) the EU finds itself in an upper-class position, but not in one indicator in the prime spot. Especially in terms of tertiary education enrollment rate the EU trails and there are more efforts needed to maintain competitiveness and the availability of advanced human capital in the future. Opposing the general public perception, the BRICS countries do not do that well in terms of investment and human capital as they would have to do to catch up, or even overtake the industrialized actors.

Infrastructure

Innovation process does not only require investment, but also a well-developed infrastructure. A central characteristic of knowledge and – as long as it is not limited by patents – scientific discovery is non-rivalness. This means that everybody can benefit from the advancement of knowledge without depriving others of this knowledge (Sachs and McArthur 2002: 170). This characteristic enables scientific cooperation, competition and advancement, but nevertheless requires certain infrastructural facilities. The sharing of knowledge, discovery and scientific data is thus heavily linked to the modern data storage and communication possibilities of the Internet. Moreover, "creating innovation system requires creating scale" (Sachs and Mc Arthur 2002: 171). Scientists that are able to cooperate with others within their working environment will produce much more scientific output and progress than isolated scientists. A well-developed network of national universities encourages research cooperation between scientists and provides a sound frame for innovation and research output in a variety of scientific fields (Sachs and McArthur 2002: 170). The selected indicators in the following section thus take into account the importance of infrastructural facilities for the innovation process such as Internet accessibility and the structure of national university systems.

Fixed (wired) Internet subscriptions and Fixed broadband internet subscribers

The emerging man-made environment of cyberspace has already changed existing power relations and societal life during the last years. Its facilities, such as Internet use, became a crucial feature for states and societies to innovate and catch-up (Fagerberg and Srholec 2008: 1420). *"Societies around the world (…) are heavily dependent on globally networked technologies. They have been locked in and interpenetrated by a digital web of their own spinning"* (Deibert and Rohozinski 2010: 12). Making money and business in our times has become dependent on the interconnectedness made possible by the Internet and the cyberspace. Because of modern data storage possibilities and the ability to connect people on far sides of the globe, the Internet facilitates the exchange of scientific research results and experimental data. Internet access also enables researchers to connect and shifts the local next-door-communication of scientists to a global digital scale (Cf. Parachissi 2002; Sachs and McArthur 2002: 172f.). Because of the illustrated importance of Internet access, the indicators of fixed (wired) Internet subscriptions as well as fixed broadband Internet subscribers (per 100 people) have been selected to give profound insight into the performance of Internet infrastructure within the selected countries.

Fixed (wired) internet subscriptions

EU, USA, Japan, Brazil and China on good levels. EU and US still in leading position. India, South Africa and Russia disastrous.

Fixed broadband internet subscribers

EU, USA and Japan on top. Brazil, Russia and China are catching up. India and South-Africa badly positioned and without improvements.

The empirical data on fixed Internet subscriptions shows a highly developed Internet infrastructure for the European Union, the United States, and China. Japan trails far behind these leading countries in terms of the total number of Internet subscriptions, but this empirical data is highly influenced by the population size.

Chart 4: Fixed (wired) Internet Subscriptions

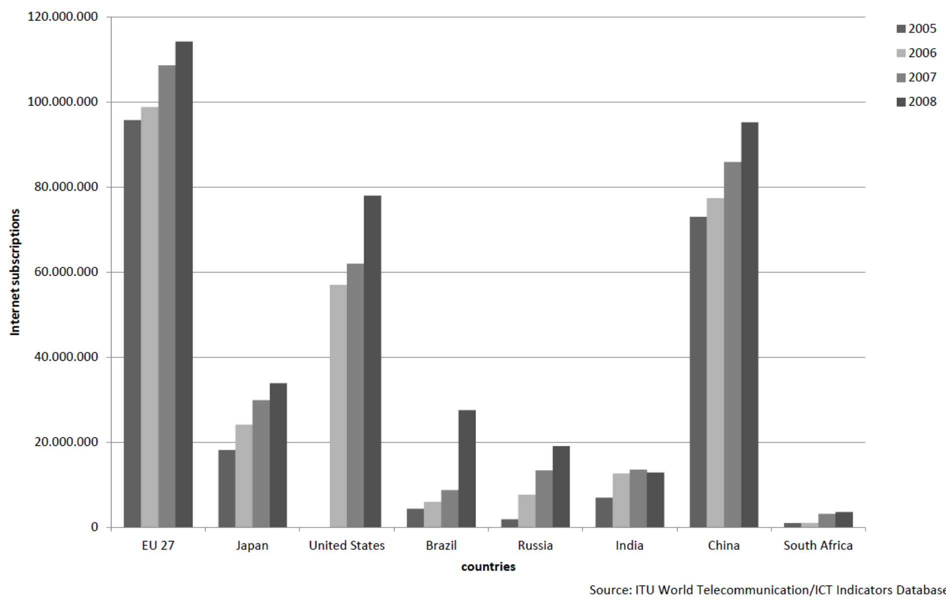
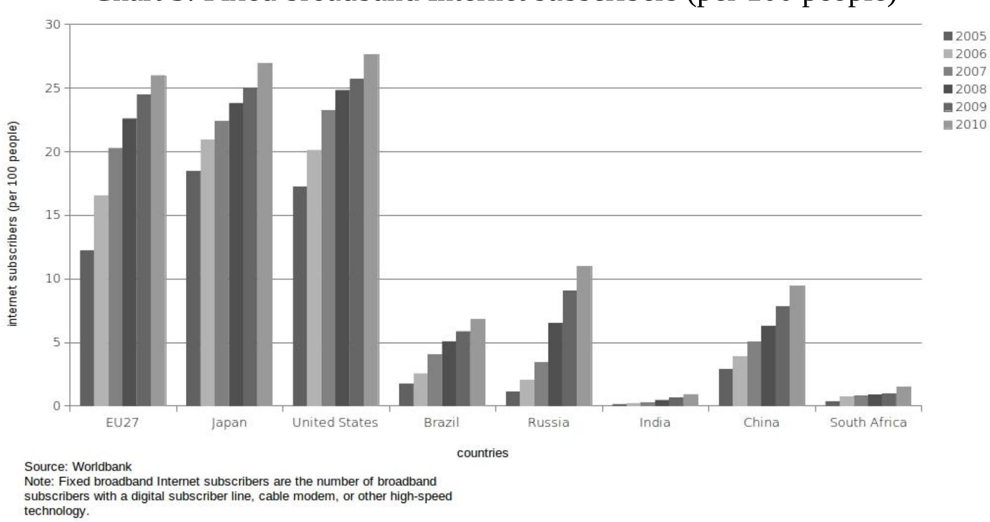


Chart 5: Fixed broadband Internet subscribers (per 100 people)



In relative terms of fixed broadband and Internet subscribers per 100 people, Japan is even one of the leading countries together with the European Union and the United States. China seems to have a well-developed Internet infrastructure in total numbers of Internet subscriptions, but if the relative number of fixed broadband Internet subscribers is taken into account, China is on a low infrastructural level among the other BRICS states.

The development and the status quo of Brazil, Russia, India and South Africa is ambivalent, surprising and alarming. Brazil succeeded in tripling its total number of Internet subscriptions from 2007 to 2008 and the relative number of fixed broadband Internet subscribers also increased during the last years. This is due to great investments and efforts made by the government. Dozens of programs have been initiated to connect the population to the Internet. In 2010 a National Broadband Plan was launched that should even triple broadband access by 2014 (Kelly and Cook 2011: 66-67). A similar situation presents itself in Russia. The country has succeeded in developing sound Internet infrastructure for both indicators. There have also been some efforts to improve the amount of Internet penetration in Russia. The Ministry of Education and Science has launched national programs that provide Internet access to all national educational institutions as well as to install open source software on every school computer. But the situation is ambivalent, because Internet and PC penetration is much higher in Moscow and St. Petersburg than in the rest of the country, especially in the rural areas (ONI 2010: 211-212). India and South-Africa are badly positioned for both indicators and without improvements during the last years. Even though governmental initiatives, such as the South African National Research Network, have tried to increase and speed up Internet connections for South African researchers, the situation is still bad. People and especially researcher and students that are heavily dependent on Internet facilities face high costs of Internet access. This structure poses a serious impediment to research and development in South Africa. The situation of the worldwide leading country of IT-experts, India, seems to be disastrous. In 2010 0.89 out of 100 people were fixed broadband Internet subscribers. But it is difficult to evaluate this situation, because India may become one of the first mobile digital societies, a digital dimension that cannot be measured by the indicators of broadband Internet subscriptions. Even if mobile Internet user access has tripled from 2007 to 2009, when it increased from 4mio to 12mio users, it is still a very low number. Nevertheless, there is a high importance of broadband Internet infrastructure especially for rural areas and measures to achieve a higher general availability of broadband Internet are taken with the National Broadband Plan (Cf. Telecom Regulatory Authority Of India 2010a; Aguiar et al. 2010: 7-11).

The European Union is one of the leading entities both in terms of fixed (wired) Internet subscriptions as well as fixed broadband Internet subscribers per 100 people. Like the EC points out in her "Digital Agenda for Europe"[8] (one of the seven flagship initiatives of the Europe 2020 Strategy): *"The development of high-speed networks today is having the same revolutionary impact as the development of electricity and transportation networks had a century ago"*[9] and the internet today is the most important medium for business, innovation and economic growth and social progress (European Commission 2010b: 3-4 and 2010c: 8-10). Therefore one aim of the "Digital Agenda for Europe" is to increase the number of broadband internet subscribers significantly and step-by-step to a 100% coverage by 2030. In comparison to other political entities (as the data indicates), the EU is already in good position regarding internet accessibility, one additional condition for fine global competitiveness (especially in ICT related business activity).

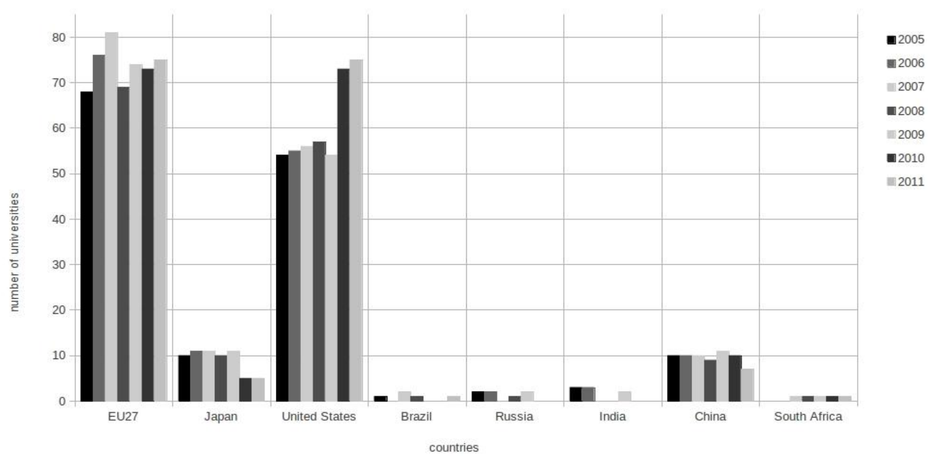
[8] Cf.: European Commission. 2010b: 3-6.
[9] Ibd.: 4.

THE Top-200 global universities

European universities on top, USA directly behind and catching up. Japan and China mediocre. Brazil, Russia, India and SA not worth mentioning

Innovation process is foremost science based and depends heavily on the quality and infrastructural characteristics of the national higher educational system. The indicators in the cluster of Investment and Human Resources have already shown the importance of investment in the higher education system, but a second meaning is accorded to a structural dimension. A well-developed national structure of high quality universities offers the possibility to train a great number of students as well as to allocate high-class researchers. Moreover, excellent research facilities create innovation in a variety of scientific disciplines. This structural dimension enables the country to address and frame urgent scientific problems as well as to dominate the global scientific discourse (Below et al. 2012: 16-17).

Chart 6a: World’s University Ranking – Times Higher Education



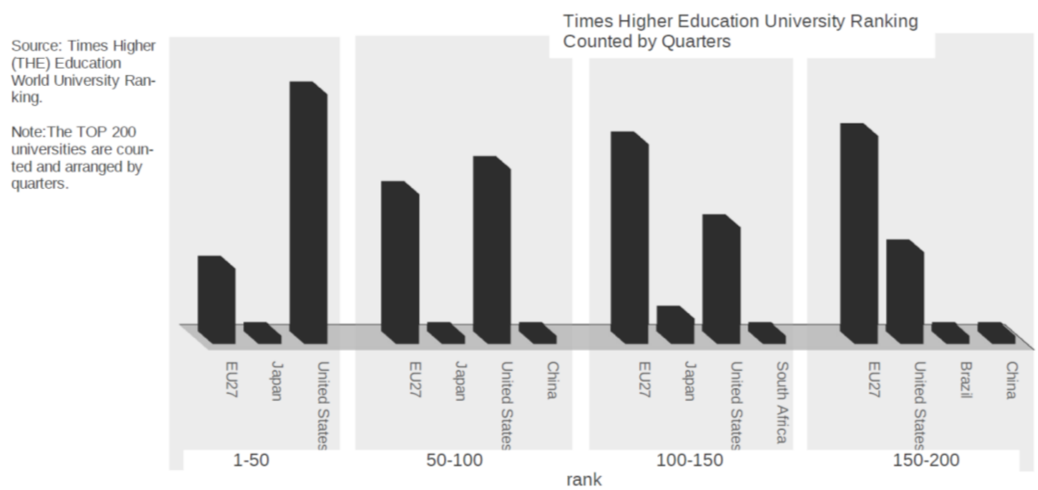
Source: Times Higher Education World University Ranking

Universities in the European Union and the United States are leading the Times Higher Education (THE) World's University Ranking in terms of the total number of universities. This is not surprising considering the long academic tradition of these countries as well as the annual budget of the leading universities. Most of the world-leading institutions like Harvard, Princeton or Yale University were founded in the 17th and 18th century. The foundation of the universities of Oxford and Cambridge can even be dated back to the 12th and 13th century. Moreover the annual financial endowment of the top 15 universities of the THE university ranking accounts for more than 1bn US$. The creation and maintenance of material resources include high-technology research facilities such as particle accelerators at the University of California, Massachusetts Institute of Technology or Cornell University that also require a great amount of annual investment. The important universities in Europe and the United States with their long research tradition benefit from a large body of experience as well as their global reputation to strengthen research and train students. They benefit from large annual investments and are able to lead the global scientific discourse. It is thus extremely difficult for newly founded research institutions in emerging economies to catch up with these world leading institutions in a couple of years.

Some national universities in China, India or Brazil such as the Chinese Nanjing University or the Brazilian Federal University of Rio de Janeiro have also been founded over a century ago and national governments have recently started to spend a huge amount to strengthen their capabilities (Below et al. 2012). But universities tend to increasingly compete in a global environment in the future (Buela-Casal et al. 2007: 350) and significant quality and financial problems still exist in universities especially in China and India: *"Many of India's impressive number of engineering graduates (…) are too poorly educated to function effectively in the economy without additional on-the-job training*" (Altbach 2009: 180). The expenditure per student for academic formation in the BRICS states is still high and they suffer from the "brain drain" to high-class research institutions in the United States or Europe that open up long-term prospects for the students (Below et al. 2012: 16-18).

The question that is left is about Japan's standing within this university ranking. As a highly developed country and leading economy in the world, it only seems to possess a handful of excellent universities. One answer might be that Japan's investment in the higher education system has been focused too long on national initiatives. Thus, Japanese universities dominate regional university rankings, but have only found a bad position in the global university league (Yonezawa 2006). The government started to invest in the internationalization of its universities a couple of years ago and academics *"have [even] launched a Flagship Universities project to identify a few major Japanese universities and develop them as 'world-class universities'"* (Deema, Mokb and Lucasa 2008: 90).

Chart 6b: World's University Ranking by Quarter – Times Higher Education



As the assessment of the indicator has proved, the EU finds itself in the second place, behind the USA, related to the total number of world's top universities. The USA has a significant larger share in numbers of the world's top 50 universities. But, like the indicator has also shown, if cutting the top 200 universities of the THE World's University Ranking in quarters, an interesting shift between the European Union and the United States can be observed: The United States still face the top-ranking positions, but European universities seem to catchup. Especially in the context of the recently intensified efforts[10] of the European Union and of several governments of the member states (p.e. the German Universities Excellence Initiative) to support and promote European universities and public research facilities, the obvious catching up of European universities has to be considered as one first sign of success of Europe's rally to the top. Furthermore, due to the fact, that rankings of higher education do not include public funded research institutes - like the Leibniz Scientific Community (endowment ap. 1,5 bn € p.a.), Helmholtz

[10] p.e. The 7th and upcoming 8th Framework Programmes for Research and Technological Development, European University Institue, the new founded European Institute of Innovation & Technology.

Association (annual budget of ap. 3,5bn €), the Fraunhofer Society (ap. 1,7bn € p.a.) and the Max Planck Society (ap. 1,5bn € p.a.) – that are responsible for a huge amount of the top-research and Nobel-prize winners of the EU (for example according to the "Thomson Scientific Impact Factor" indicator the Max Planck Society is ranked the world's most important institution in physics, space sciences and the 2nd / 3rd most important and influential intuition in the world related to material science, biology, biochemistry and molecular biology) a vast amount of European research capability and excellence is not accounted for by higher-education rankings. Howsoever, the research performance of these public institutes is at least on the same level as the performance of any American top-10 university. Altogether it can be argued, that the EU's universities and research institutions are of finest international quality and that the EU has to fear no comparison related to this indicator, but should not stop its efforts to grow to be the region which inhabits the world's finest institutions of higher education.

Summary "Infrastructure": The EU finds itself in all three indicators in either the prime spot (Fixed (wired) Internet subscriptions and Fixed broadband Internet subscribers), or at least among the top-tier entities (THE Top-200 global universities). Hence, it can be stated that the EU, in terms of innovative capabilities in the category of infrastructure, is equipped excellently and operates at a high level of competitiveness.

Research-Productivity

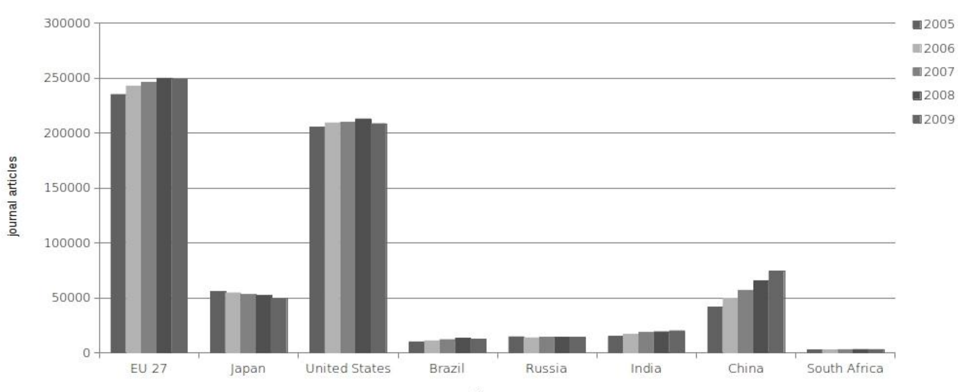
The selected indicators put a great emphasis on the structural and commercial characteristics of scientific research output. They are thus closely linked to the public spending on education. The indicators of the number of scientific journal articles and citations measure the distribution of scientific discovery and knowledge. The indicator of citations possesses high structural implications by taking into account the quality of a journal article. This approach differs from other indexes on Innovation Capacity. The Science and Technology Capacity Index developed by the RAND Corporation for example *"uses a co-authorship index as a source of information on the international integration of countries' academia"* (Archibugi and Coco 2005: 183; Wagner et al. 2001). A country that has a great number of both journal articles and citations is thus able to dominate and lead the scientific discourse. The patent indicators show the country's capability to commercialize scientific discovery and knowledge. In contrast to other studies (p.e. Archibugi and Coco 2005:188; Desai et al. 2002; UNDP 2001), the patent indicators here are not used to illustrate technology creation, but research productivity and output as a keystone of national innovative capacity by linking them to the annual research and development expenditure.

> ***Scientific journal articles***
>
> EU and USA perform outstandingly. Japan does well and China is catching up. Brazil, India, Russia and SA rock bottom positions.

> ***Citations***
>
> EU6 has first place, US and Japan perform well. China midfield position. Brazil, India, Russia and SA irrelevant.

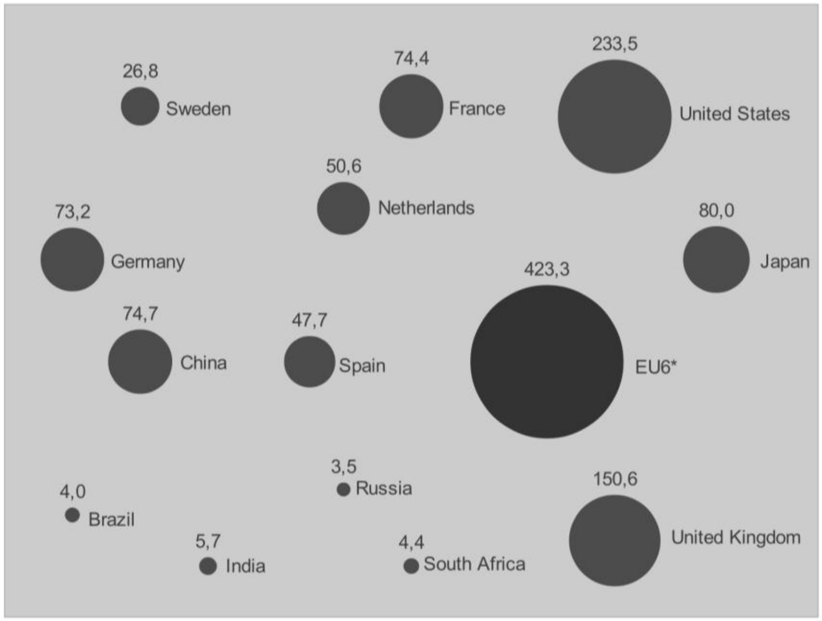
The role of academic institutions has already been taken into account by presenting their standing within the global Times Higher Education University ranking. But by using the number of scientific publications as well as the number of citations, a greater emphasis is put on the output of scientific research – not only within academic research facilities, but also within public research centers. These two indicators are closely linked to the public spending on (higher) education (Archibugi and Coco 2005: 183). Moreover the indicator of scientific journal article has a wide country coverage, whereas other indicators are only available for a more limited sample of countries. It is also *„able to account for a large portion of cross-country variability for both industrialized as well as less developed economies“* (Castellacci 2008: 304). The indicator of citations is not yet available for all European Union member states due to the complex data selection process, but it nevertheless takes into account the global standing of emerging economies such as the BRIC states as well as the biggest economies within the European Union.
The limitations for the indicator of scientific journal article may be the quality of journal articles that varies from country to country according to their selection process as well as the amount of English-speaking countries that may be over-represented (Archibugi and Coco 2005: 183). For the indicator of citations, it is true that English journal articles are more likely to be cited than others. But the indicator of citation does not possess the limitation of quality that is considered the most important one of these two. Because the global number of citations of a journal article is counted, the quality is not only accorded to a national selection process, but foremost to the judging of worldwide experts that take into account the high quality of an article by citing them.

Chart 7: Scientific and Technical Journal Articles



Source: Worldbank
Note: Scientific and technical journal articles refer to the number of scientific and engineering articles published in the following fields: physics, biology, chemistry, mathematics, clinical medicine, biomedical research, engineering and technology, and earth and space sciences.

Figure 1: Citation



Source: Reuters Web of Knowledge, Citation Database/ Counting Procedure developed by CGS Research Group "Rising Knowledge Powers"
Note: The number of citations are based on an specific counting procedure for scientific papers that are cited at least 150 times. Counting procedure differentiate between author and co-author: 1 point is given to each author, the scores of the co -authors depend on the number of co-authors that participated in the scientific paper.The bubbles represent the amount of points for each country.
***EU6 = Germany, France, United Kingdom, Sweden, Netherlands, Spain**

The data on scientific and technical journal articles and citations show an immense gap between the European Union and the United States on the one hand and Japan as well as the BRICS states on the other hand. The latter are trailing far behind for both indicators. The capability of the European Union and the United States to publish a high number of scientific and technical journal articles can be traced back to the good quality of the scientific infrastructure in these countries. This has been shown by the previous indicators and is, among others, linked to a good standing within the global university rankings. Japan, despite its high-technology capabilities, is far behind the European countries and the United States. It has already been illustrated that Japan's low position within the THE university ranking is due to national investment in the higher education system that has been focused on national initiatives for too long (Yonezawa 2006). Apparently national research and scientific publications were also focused on national and regional issues and thus, did not matter within the global scientific discourse.

The illustrated gap is maintained when considering the number of citations. Those countries with a high number of publications also seem to be globally recognized in terms of scientific quality. Especially the scientific output of the European Union seems to be of outstanding quality according to the interpretation of the citation indicator. In 2008, the researchers in the European Union published 250,000 journal articles, 212,000 journal articles were published in the United States the same year. However, according to the counting procedure of citations, the citations of 6 member states of the European Union are almost twice the amount of citations of US-American scientific articles.

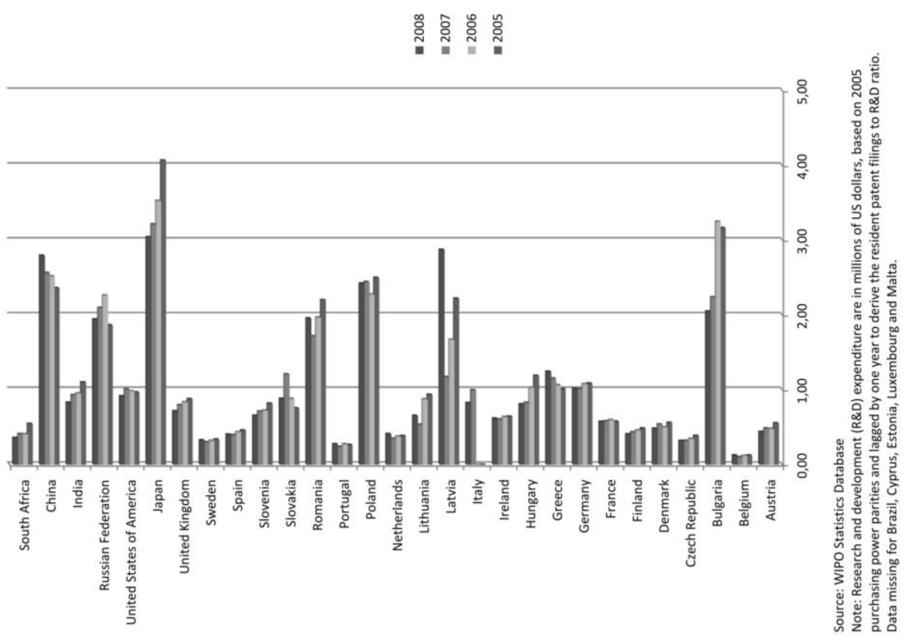
Patent fillings per 1m$ R&D expenditures and Total Number of Patent Families by Country of Origin

Patent fillings per 1m$ R&D expenditures

China, Russia and Japan are remarkably efficient. USA and most European countries moderate.

Japan and China possess the highest research productivity and efficiency counted in patent filings per 1Mio US$ research and development expenditure. Brazil, Russia and India are also among the leading countries as well as some small economies of the European Union such as Poland, Latvia or Bulgaria.

Chart 8: Patent Filings per 1m US$ R&D Expenditure



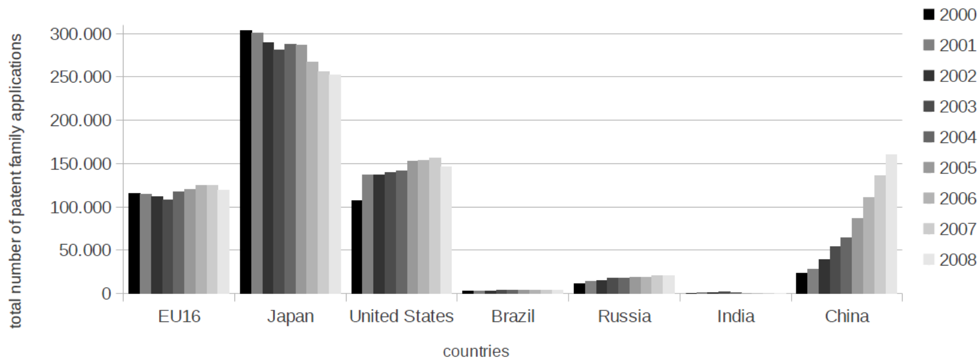
Japan's standing in terms of patent family applications is excellent and China has been catching up for a couple of years. Its patent family applications doubled between 2005 and 2008 and passed the United States in 2008. It is surprising that the United States trail behind especially in terms of patent fillings per 1Mio US$ research and development expenditure. The United States are commonly considered as one of the leading scientific nations. They are on the top of a lot of indicators measuring research productivity such as journal articles and citations as well as the quality of scientific infrastructure such as the THE World's University Ranking. But also other countries that posses a long research history and a sound scientific infrastructure such as the United Kingdom, Germany or the Netherlands trail behind.

Total Number of Patent Families by Country of Origin

Japan outstanding. US and EU are doing well. China is (once again) catching up. All others non-existent.

In terms of patent family applications, Brazil, Russia and India are far behind, whereas the United States, European countries and especially Japan have a solid standing.

Chart 9: Total Number of Patent Families by Country of Origin



Source: WIPO Statistics Database, 2011
Note: A patent family is defined as a set of patent applications inter-related by either priority claims or PCT national phase entries, normally containing the same subject matter. Statistics based on patent family data eliminates double counts of patent applications that are filed with multiple Offices for the same invention. Counts are based on the priority (first filing) date. Country of origin is the residence of the first-named applicant (or assignee).

The fact that international patent applications are typically more costly than domestic ones can serve as an explanation for this lower number (Grupp and Schmoch 1999). Companies that invest in a variety of foreign markets *"would have a strong motivation to seek intellectual property protection overseas when the risk of its products being imitated, which depends on the technological sophistication of firms in the host country"* (Huang and Jacob 2012: 7). The data on patent family applications illustrate that very few patent families created by Brazil, China and the Russia contained more than one patent office, whereas a great amount of patent applications by European countries, the United States or Japan include at least two offices: Leading high-industrialized countries seemed to protect their high-technological inventions on emerging markets in the past, but the Chinese catch up in terms of patent family applications illustrates the competitiveness of the Chinese technological advancement.

Summary "Research Productivity": When it comes to the category of "research productivity" the performance of the EU is ambivalent. While the EU performs very well with regard to scientific journal articles, citations and patents applications by country of origin, the EU's performance regarding the total number of patent families by country of origin is only moderate.

Global Market Performance of the European Union

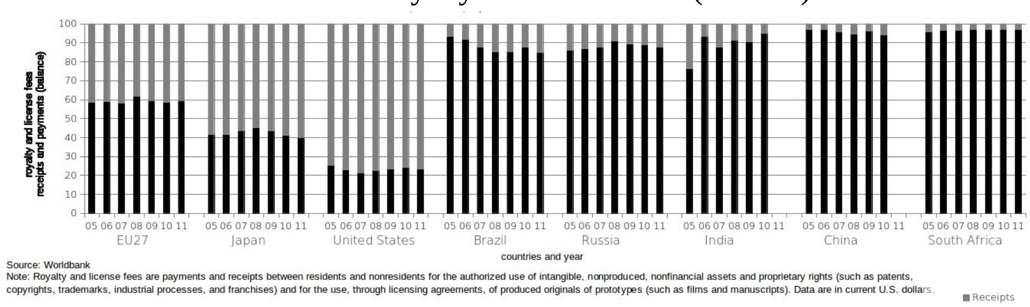
This last part of the paper examines the global market performance of the European Union. Global market performance in this regard is understood as *the success in international trade (measured in terms of shares in commercial services and merchandise trade), the international rating of companies that are legally based in the entity's territory (Forbes 2000), as well as the attractiveness and profitability of codified and applicable knowledge owned by public or private actors legally based in the political entity's / state's territory (royalty and license fees balance).* All the indicators chosen in this category are able to measure the economic success rate and market efficiency of an entity, by looking at specific market-related output indicators. In difference to the category "research productivity" this category only focuses on indicators that are a direct expression of market usability of codified knowledge (royalty and license fees balance), market power and performance of companies (Forbes Global 2000), or of an entity's performance in international trade (trade in merchandise and services). Therefore, the common ground of the indicators selected here is that they are able to give direct insight into the market performance and efficiency of an actor. Whereas the indicators of the category "research productivity" indeed are suitable to provide information on efficiency in relation to academic research and the use of resources in the process of the creation of knowledge, they are not able to give information on the market performance economic usability of these works. Looking at who pays more for the use of others' innovations and knowledge, than he receives for his own innovations and knowledge used by others (royalty and license fees balance), who runs the global economy in terms of economic weight and size (Forbes Global 2000) and who trades most (services and merchandise), gives profound insight into the overall global market performance of actors. Although it is not the aim of this paper to establish a statistical or theoretical relationship between one actor's endowment in terms of innovative capabilities (IC) and its global market performance (that will be the task of the authors' future research), based on the authors' remarks on the mode of action of the different indicators and their influence on an entity's competitiveness, it has to be assumed that a good standing in terms of IC endowment might lead to superior global market performance. As shown above, the EU is in most indicators very well ranked regarding its innovative capabilities; hence we can also assume the EU to be well-positioned in terms of its global market performance, which is actually the case (as shown below).

Royalty and license fees balance

USA and Japan recipients. EU nearly balanced. Brazil, Russia, India, China and SA are the paymasters.

The indicator "royalty and license fee balance" is often used as a benchmark for the economic usability of codified and/or patented and/or copy right protected knowledge, processes and technology that originate in a political entity (cf. Below 2012 et al.: 15-17; UNIDO) and therefore gives an overview about the economic revenue of applied knowledge and technology, by showing the balance of receipts and payments. Furthermore, the royalty and license fees balance gives a general idea about whose economy is - in economic terms - more efficient in the creation and worldwide sale of technology and knowledge.
As we can learn from chart 10, the US and Japan are the only two actors with a positive balance in royalty and license fees, so in fact, those two economies are the only two on a global level that receive more fees from others for the use of technology/knowledge created by their economies, than they have to pay for using others' knowledge etc. The EU again shows a nearly even balance rate of royalty and license fees. Although the EU is performing on a fair level, the economic usability of knowledge and technology developed in the EU is not as high as of knowledge and technology developed in the USA or Japan.

Chart 10: Royalty and license fees (balance)



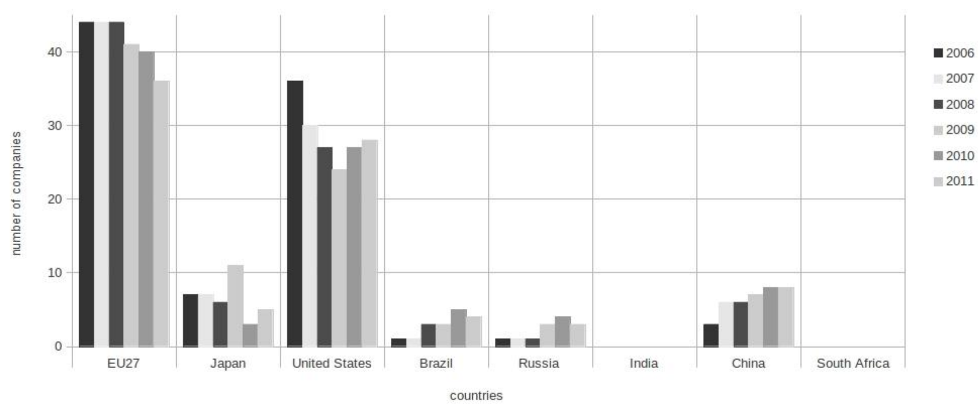
On the other hand, all BRICS states are horribly positioned and have a totally negative balance of royalty and license fees. In plain language, this means that on a global level nearly nobody uses licensed knowledge and technology developed in one of the BRICS countries, but the BRICS countries are obviously (still) totally depended on foreign knowledge and technology for their production. Despite the fact, that a lot of "analyses" and commentaries claim that the BRICS countries have become more than just the world's workbench, the careful analysis of the data shows that market competitiveness of knowledge and technology developed in the BRICS countries is nothing more than a fairytale. Most of the products manufactured in the BRICS countries are produced under license, or just assembled in one of the BRICS by local companies for western companies. At least in this category the BRICS states are still light-years away from the level of competitiveness of the industrialized countries/entities.

Forbes Global 2000

Majority of the world's leading companies situated in the EU and US. Japan and China have fair positions. Brazil and Russia on the sheet. India and SA non-existent.

Another approach suitable to estimate the global market performance of an entity is to look into the global standing of the companies that are based in one entity's territory. To do so, the paper uses the data of the Forbes Global 2000 survey and counts the global top 200 companies by entity. In general it can be argued, that a large number of highly profitable, valuable and top-selling companies legally based in one political entity's territory are an expression of the entity's economy competitiveness and economic efficiency, and furthermore one pre-condition for high tax income and wealth.

Chart 11: Forbes Global 2000 – The World's Leading Companies



Source: Forbes Magazine
Note: Global 2000 list is compiled by screening Interactive Data, Thomson Reuters Fundamentals and Worldscope databases via FactSet Research Systems for publicly traded companies.

As we can learn from chart 11, the majority of the world's leading companies are to be found in the EU and US. In other words, mainly US and European enterprises run the global economy. China and Japan are positioned in the mid-field while Brazil and Russia are in lower-class positions. Not one Indian or South-African enterprise is a member of the top-200 club. In terms of sales, profits, market value and assets American and European companies are top performers and the EU hosts most of the world's top companies.

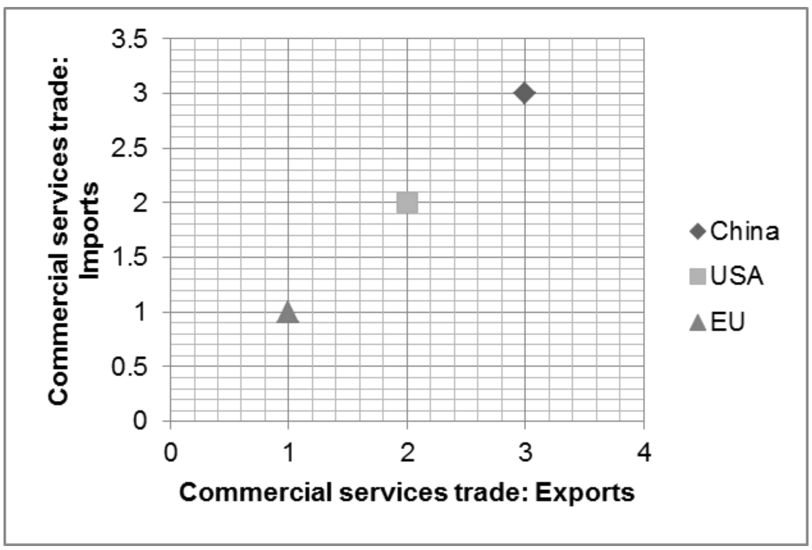
Commercial services trade performance and merchandise trade performance[11]

In IR little has been written about the relationship of trade and power so far. However, a good performance in international trade measured in terms of global market shares is believed to be one condition for a political entity to convincingly use economic sanctions (for example Hirschman 1980). Furthermore, a large market on the one hand and the promise of market access on the other hand can be used as a valuable bargaining chip in international negotiations (cf. Meunier and Nicolaidis 2005; Meunier 2006 and 2007), or can be used to (often coercively) externalize market-related policies and regulations (Damro 2012). In addition, from an economic point of view, large shares in international trade are an indicator for competitiveness and economic advancement of an economy.

Commercial services trade performance

EU top-ranking, USA second, China third.

Figure 2: Commercial Services Trade Performance



Source: WTO Trade Statistics
Methodology: Based on the following WTO Trade Statistics Categories for commercial service trade: Transportation services, Travel, Communications services, Telecommunications services, Construction, Insurance services, Financial services, Computer and information services, Computer services, Other business services, Personal, cultural and recreational services, Audio-visual services, the overall market performance of the US, China and the EU was measured, by ranking the shares of export and import in every category (1 = highest market shares and 3 = lowest market shares in this category) and then weighting them according to their respective value in $, as well as their market performance in terms of import shares (1st, 2nd, 3rd). The overall ranking for "Commercial Services Trade" (1st, 2nd and 3rd rank) is therefore the outcome of the total number of first (1), second (2) and third (3) place ratings of the US, China and the EU in those categories.
Note: Data for 2011.

Based on WTO Trade Statistics Categories for commercial services the overall market performance of the US, China and the EU was measured, by ranking the shares of export and import in every category (1 = highest market shares,3 = lowest market shares in this category) and then weighting them according to their respective value in $, as well as their market performance in terms of import shares (1st, 2nd, 3rd). The overall ranking for "Commercial Services Trade" (1st, 2nd and 3rd rank) is therefore the rounded outcome of the total number of first (1), second (2) and third (3) place ratings of the US, China and the EU in those categories.

Like expressed by Figure 2, the EU is top positioned in commercial services exports and imports, followed by the US and China. The European market is highly integrated in the global market and the EU sells and buys the largest amount of commercial services worldwide. This is one proof of the importance of the European market for international trade and of the high level of competitiveness of European products.

[11] Note: The following two indicators are a first sneak preview of research "in progress" and therefore not fully tested yet.

Merchandise trade performance

EU first, China and USA close by.

Using the same methodology like the commercial services trade performance, but using WTO categories for commodities of merchandise trade, the merchandise trade performance of the US, EU and China has been measured. In both categories (exports and imports) the EU is once again in the 1st place regarding market shares and market performance.

Figure 3: Merchandise Trade Performance

Source: WTO Trade Statistics
Methodology: Based on the following WTO Trade Statistics Categories for commercial service trade: Manufactures, Machinery and transport equipment, Office and telecom equipment, Electronic data processing and office equipment, Clothing, Telecommunications equipment, Textiles, Agricultural products, Chemicals, Food, Fuels and mining products, Fuels, Integrated circuits and electronic components, Iron and steel, Automotive products, Pharmaceuticals, the overall market performance of the US, China and the EU was measured, by ranking the shares of export and import in every category (1 = highest market shares and 3 = lowest market shares in this category) and then weighting them according to their respective value in $, as well as their market performance in terms of import shares (1st, 2nd, 3rd). The overall ranking for "Commercial Services Trade" (1st, 2nd and 3rd rank) is therefore the outcome of the total number of first (1), second (2) and third (3) place ratings of the US, China and the EU in those categories.
Note: Data for 2011.

Summary "Global Market Performance of the European Union": Except for the indicator of royalty and license fees balance the EU is positioned in the prime spot. In international Trade the market performance of the EU is superior.

Conclusion

The paper has offered an insight to the EU's innovation capabilities and market performance in international comparison. It has answered the question of EU's standing in international comparison and whether traditional powers are outrun by emerging powers. The indicators presented in this paper do not use traditional approaches like measuring GDP or high-technological exports, but rather innovative measuring of innovative capabilities and market performance that focus on input, output, commercialization and economic usability.

The paper has presented four sections that cluster different indicators. With regard to the indicators of Investment & Human Capital the EU finds itself in an upper-class position, but not in one indicator in the prime spot. Especially in terms of tertiary education enrollment rate more efforts are needed to maintain competitiveness. Opposing the general public perception, the BRICS countries do not do that well in terms of investment and human capital as they would have to in order to catch up with, or even overtake the industrialized actor.

For the indicators of the category Infrastructure it can be stated that the EU is excellently equipped and operates at a high level of competitiveness. The same can be said about the outcome of the Research Productivity indicators, except for the EU's performance regarding the total number of patent families by country of origin, which is only moderate. Except for the indicator of royalty and license fees balance the EU is positioned in the prime spot and its market performance in international trade is superior.

The United States and the European Union lead the international community in terms of innovation capabilities and market performance. This is due to well-directed investments and policies during the last years as well as their long research tradition that offers a large body of experience and international reputation. The EU's capabilities to compete and its rank in international economic affairs, based on latest data, are outstanding.

Quite interestingly the positioning of the BRICS is weak in nearly all indicators presented. Even China's position (despite her international importance in terms of trade and economic issues) is not as good as it might have assumed to be in the context of the ongoing debate of a power shift between China and the EU/USA. Opposing the general public perception, this paper has also shown that the BRICS countries do not do that well in terms of investment and human capital, infrastructure and research productivity as they would have to do to catch up with, or even overtake the industrialized actors. India and South Africa perform badly and there has been no progress over the last years. Brazil on the other hand shows some progress in most of the indicators. The poor and very inhomogeneous overall results of the BRICS countries' performances also question the BRIC(S) concept and ongoing debate about a perceived power shift more generally/fundamental and open up the need for further research on these questions (that we will deal with in an upcoming paper). The even worse performance of South-Africa compared to the other BRICS states is also a matter which has to be addressed separately in a future paper.

Summing up, this paper has evidently and forcefully shown that the European Union ranks in many of the indicators related to innovative capabilities in good/very good position and the EU's overall global market performance is excellent, whereas the BRICS underachieve. Despite the challenges the EU faces today, it becomes obvious that the good standing of the EU is owed to the fact that the EU is regarded in its entirety, which should provide another argument for further European integration.

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