The transition from factor driven economies to innovation driven economies - the case of BRIC and GCC countries

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BRIC and GCC countries national innovation systems: introduction

Why we take BRIC and GCC countries?

BRIC countries are the upcoming nations in terms of economic power and innovation development with big resources (human, financial and infrastructural) for developing innovation economy

GCC countries with completely different base (much smaller population and a much larger capital base (in relative terms)) are also looking to evolve into an innovation-driven economy

GCC countries also have well developed institutional and infrastructural base as well as good business environment

However investments in R&D and R&D human capital in GCC countries are much lower than in BRIC countries

We analyze how countries with different characteristics but similar main innovation policy goal try to achieve this goal

Can we compare BRIC and GCC countries?

All the countries studied have similar aspirations in attempting to transition towards an innovation-driven economy, yet they all show very different approaches and success

Moreover differences in innovation economy development within BRIC countries are much higher than within GCC

We analyze not only countries themselves but ways in transition to innovation economy in this countries

BRIC and GCC countries national innovation systems: introduction

Research questions

- General trends in national innovation system (NIS) development

- Strengths and weaknesses of NIS in the countries studied

- Differences/similarities in NIS development dynamics

- Threats and challenges for further NIS development

Approaches and methods used for analysis

- R&D expenditure dynamics and structure analysis

- Patent analysis

- Analysis of publication activity

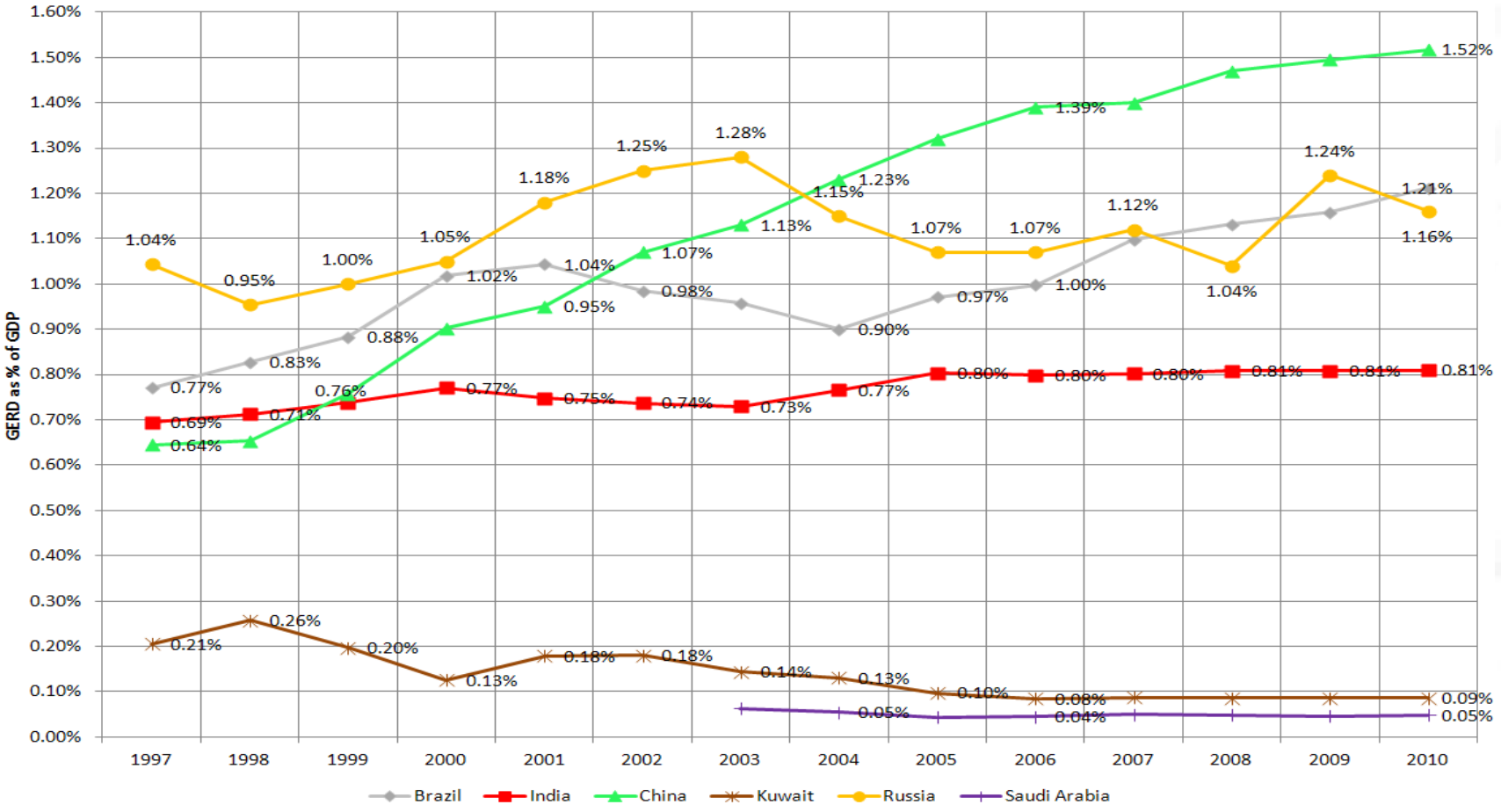
- High-tech production and export dynamics analysis

- Global country rankings analysis

Sources of information

Comparison was based mostly on secondary data from national and international statistical database such as OECD.Stat, Euromonitor, Web of Science, Scopus, World Bank

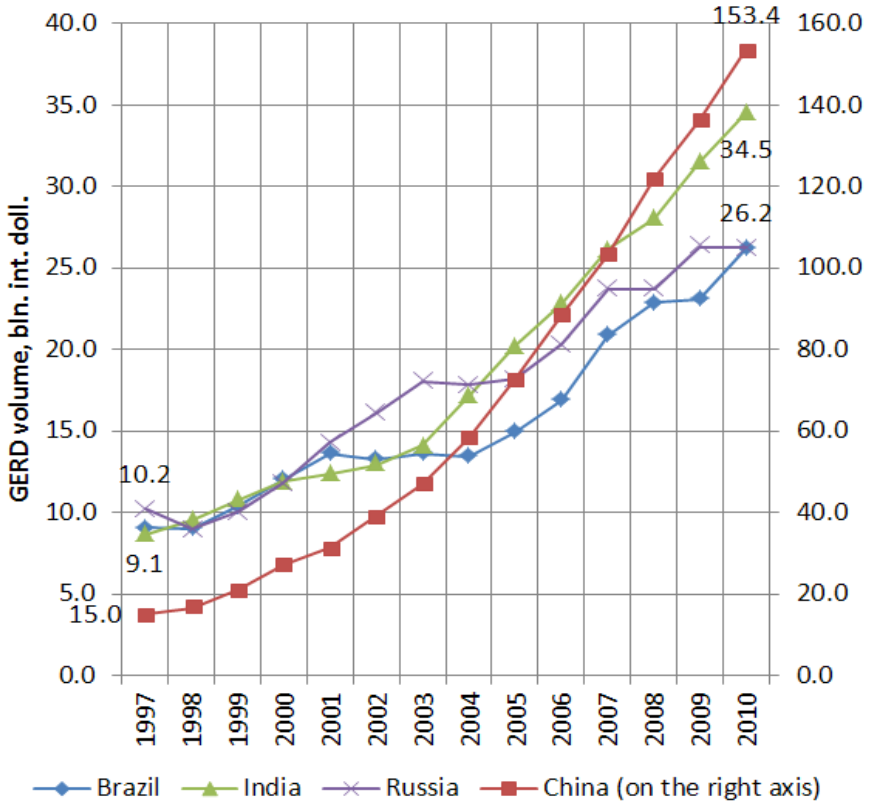
Dynamics of GERD as percentage of GDP in BRIC and some GCC countries in 1997 – 2010



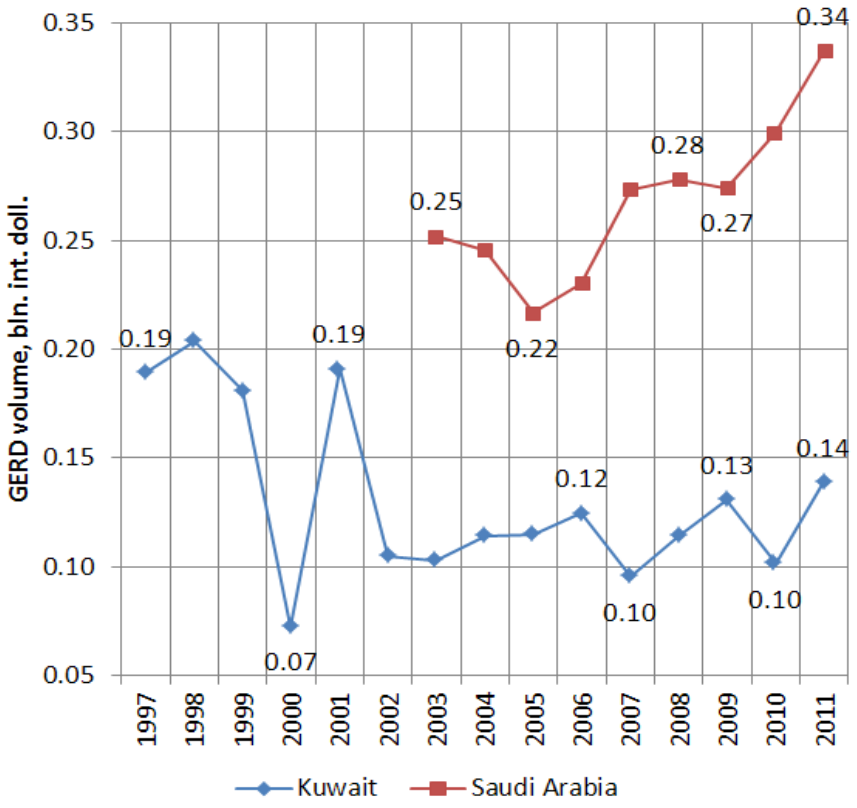
Source: Authors' calculations from the materials of Euromonitor Global Market Information Database (Section "Government, Labour and Education") derived from national statistics.

Dynamics of GERD volume in BRIC and some GCC countries in 1996 – 2011 (bln. int. doll., current prices)

BRIC countries



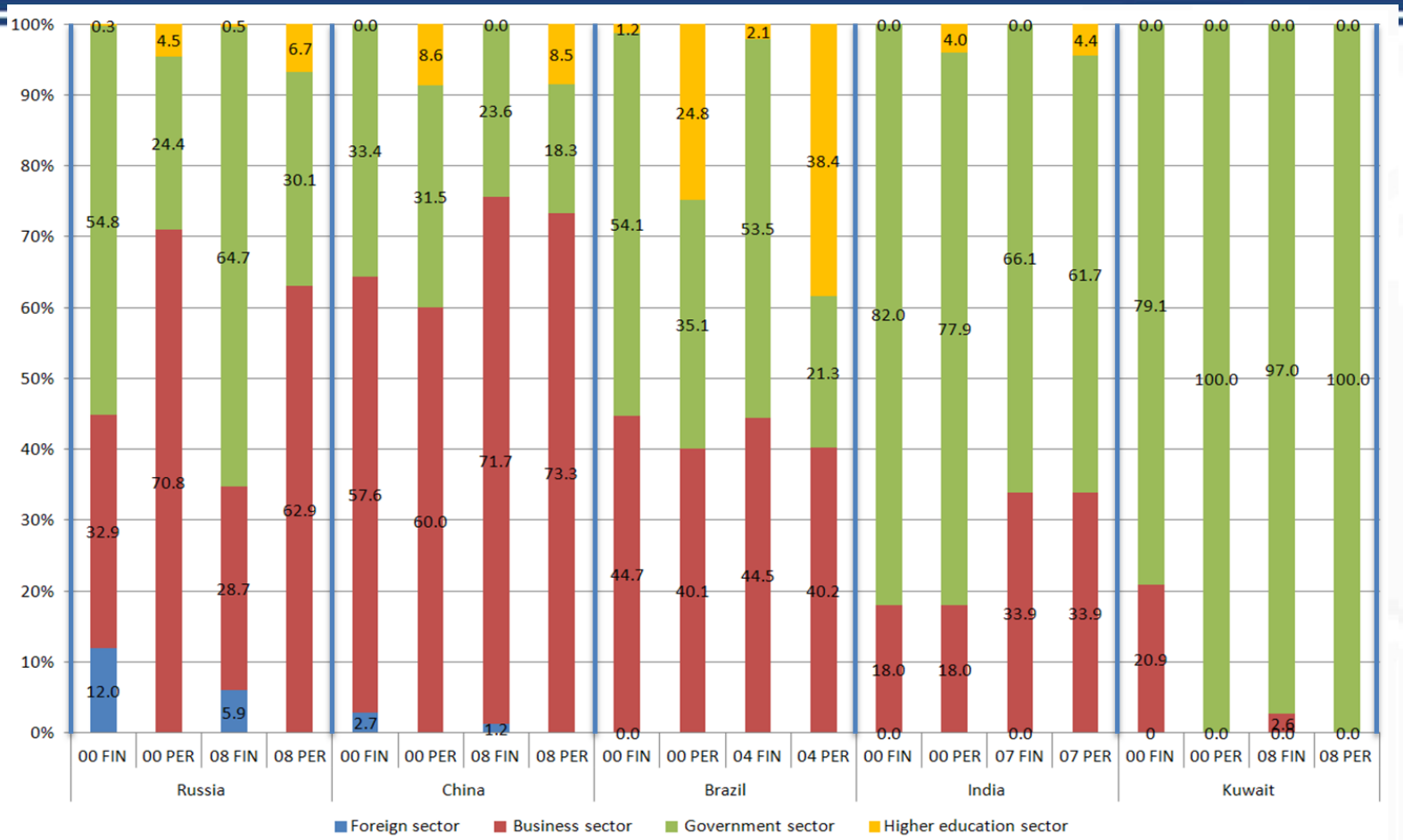
GCC countries



Notes. 1. Data for 2011 are preliminary.

Source: Authors' calculations from Euromonitor Global Market Information Database (Section "Government, Labour and Education") derived from national statistics.

Institutional structure of GERD financing and performance in BRIC countries and Kuwait in 2000 and 2008 (in %)



Notes. 1. “FIN” means financing, “PER” means performance.

2. “00” is 2000 and “08” is 2008.

Source: Authors’ calculations from the materials of Euromonitor Global Market Information Database (Section “Government, Labour and Education”) derived from national statistics.

Human resources of national innovation system in BRIC and GCC countries

- **Number of researchers (FTE and HC[1, 2], in `000)**

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Change for 1998 – 2009 (%)	Std. dev. of growth rates for 1999 – 2009 (%)
Brazil	**54.9**	**63.8**	73.9	77.9	82.2	90.0	98.3	109.4	116.7	124.9	133.3	**139.6**	**154.3**	**4.0**
China	485.5	531.1	695.1	742.7	810.5	862.1	926.3	1 118.7	1 223.8	1 423.4	1 592.4	**1 576.9**	**224.8**	**8.5**
India	117.5	**116.7**	115.9	**125.7**	**135.4**	**135.4**	**145.1**	154.8	**142.5**	**144.2**	**145.9**	**147.7**	**25.7**	**4.9**
Russia	492.5	497.0	506.4	505.8	491.9	487.5	477.6	464.6	464.4	469.1	451.2	442.3	**-10.2**	**1.8**
Kuwait	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.5	0.4	0.4	**33.3**	**14.2**
Saudi Arabia	1.0	1.2	1.2	1.2	1.5	**1.3**	**1.2**	**1.1**	**1.1**	1.0	1.2	1.3	**30.0**	**13.3**

- **Estimated[1] Dynamics of number or researcher (FTE and HC[2]) per 10 000 of employed population**

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Change for 1998 – 2009 (%)	Std. dev. of growth rates for 1999 – 2009 (%)
Brazil	7.7	8.7	9.8	10.5	10.7	11.6	12.0	12.6	13.2	13.9	14.4	15.0	**94.8**	**3.7**
China	7.1	7.7	10.0	10.6	11.5	12.0	12.7	15.1	16.4	19.0	21.1	20.9	**194.4**	**8.4**
India	3.5	3.4	3.4	3.6	3.8	3.7	3.9	4.0	3.6	3.6	3.5	3.5	**0.0**	**4.7**
Russia	82.7	81.5	80.2	79.0	74.3	73.2	71.0	68.1	67.5	66.5	63.6	63.8	**-22.9**	**1.8**
Kuwait	3.4	3.2	3.0	3.1	3.1	3.1	3.2	3.2	3.2	3.7	3.1	3.0	**-11.8**	**7.8**
Saudi Arabia		2.2	2.1	2.1	2.4	2.0	1.7	1.6	1.5	1.4	1.6	1.6	**-27.3**	**10.4**

- **Estimated[1] dynamics of GERD per researcher[2] (ths. int. doll.)**

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Change for 1998 – 2009 (%)	Std. dev. of growth rates for 1999 – 2009 (%)
Brazil	164.0	163.6	162.6	174.3	160.9	150.8	136.6	136.2	144.8	167.2	171.6	165.1	**0.7**	**7.3**
China	34.2	39.4	38.9	42.3	48.2	54.3	62.8	64.9	72.1	72.6	76.5	86.4	**152.6**	**6.0**
India	81.0	92.0	102.7	98.3	95.4	104.5	118.0	130.4	160.3	181.2	191.9	213.4	**163.5**	**7.7**
Russia	18.2	20.2	23.3	28.2	32.7	36.9	37.3	39.2	43.7	50.6	52.6	59.4	**226.4**	**6.0**
Kuwait	618.2	555.2	223.8	568.5	302.0	286.3	305.6	298.2	317.6	202.0	282.9	325.9	**-47.3**	**57.0**
Saudi Arabia						197.0	211.1	196.3	214.2	261.1	231.4	215.8	**9.5**	**12.7**

Notes. 1. For Brazil, China, India and Saudi Arabia data on number of researchers was restored by method of extrapolation. Only for Russia and Kuwait we have real data, without extrapolation (extrapolated data on number of researchers are highlighted in **green bold text**).

2. For Saudi Arabia data on number of researches are in head count representation, for all other country in full time equivalent representation.

Source: Authors' calculations from the materials of Euromonitor Global Market Information Database and UNESCO Institute for Statistics Data Centre.

Patent activity (national and international level)

National patent applications in BRIC countries and Saudi Arabia

	Total number of patent applications (resident and non-resident) to the national patent office					Share of patent applications to the country office in the global number of patent applications					Share of non-resident patent applications in the total number of patent applications to the country office				
	1995	2000	2005	2009	2010	1995	2000	2005	2009	2010	1995	2000	2005	2009	2010
Brazil	7.4	17.4	20.0	21.9	22.7	0.8%	1.4%	1.3%	1.3%	1.3%	63.7%	82.3%	80.5%	82.1%	88.1%
China	18.7	51.9	173.3	314.6	391.2	1.9%	4.1%	11.1%	18.6%	22.3%	46.5%	51.2%	46.1%	27.2%	25.1%
India	6.6	8.5	24.4	34.3		0.7%	0.7%	1.6%	2.0%		76.5%	74.2%	80.6%	78.8%	
Russia	24.4	32.3	32.3	38.6	42.5	2.5%	2.5%	2.1%	2.3%	2.4%	28.2%	27.7%	26.7%	33.6%	32.4%
Saudi Arabia	0.7	0.9	0.5		0.9	0.1%	0.1%	0.0%		0.1%	96.2%	91.3%	75.9%		69.1%

Number of resident patent applications per 1 mln. of employed population

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Change for 1998 – 2009 (%)	Std. dev. of growth rates for 1999 – 2009 (%)
Brazil	34.9	38.4	40.8	44.8	43.8	47.5	48.3	45.0	43.1	44.8	44.1	42.1	**20.6**	**6.2**
China	20.1	22.7	36.5	42.9	56.5	79.0	90.2	126.2	163.9	204.3	257.8	303.6	**1410.4**	**14.2**
India	6.7	6.4	6.5	6.8	7.6	9.4	10.8	12.2	14.4	15.7	15.4	17.2	**156.7**	**8.6**
Russia	276.3	326.3	370.2	387.0	358.2	374.9	341.7	346.6	405.3	389.9	390.6	369.2	**33.6**	**9.6**
Saudi Arabia		13.2	13.3	8.1	9.8	8.6	11.5	17.3	16.2	17.9			**35.6**	**28.1**

Patent applications filed under the Patent Cooperation Treaty

	Total number of patent applications						Share of country applications in the global number of patent applications					
	1985	1990	1995	2000	2005	2009	1985	1990	1995	2000	2005	2009
China	0	10	114	1 571	3 859	10 476	0.0%	0.0%	0.3%	1.5%	2.7%	6.9%
India	2	7	18	268	1 087	1 448	0.0%	0.0%	0.0%	0.3%	0.8%	1.0%
Russia	37	153	288	590	769	771	0.5%	0.7%	0.6%	0.6%	0.5%	0.5%
Brazil	26	30	67	177	346	515	0.4%	0.1%	0.2%	0.2%	0.2%	0.3%
Saudi Arabia	0	1	3	11	39	58	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
UAE	0	0	1	10	8	27	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Kuwait	0	0	0	0	4	0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Source: Authors' calculations from the materials of World Intellectual Property Organization (WIPO) database and OECD.Stat database

Publication activity (Web of Science database, data for 2001 – 2011 years)

	Number of papers (ths.) for 2001 – 2011	Position in the global ranking of the number of papers in 2001 – 2011	Growth of the number of papers (by a factor of) 2001-2005 – 2007-2011	Change of position in the global ranking of number of papers 2001-2005 – 2007-2011	Position in the global ranking of the number of citations 2001- 2011	Growth of the number of citations (by a factor of) 2001-2005 – 2007-2011	Change of position in the global ranking of number of citations 2001-2005 – 2007-2011	Average number of citation per paper (ACP indicator) 2001 – 2011	Position in the global ranking of the ACP indicator level 2001 – 2011	Ratio to the total world level of the ACP indicator 2001 – 2011	Growth of the ACP indicator level (by a factor of) 2001-2005 – 2007-2011	Change of position in the global ranking of the ACP indicator level 2001-2005 – 2007-2011
BRIC countries												
Brazil	225.7	15	***2.00***	3	19	2.36	5	6.37	90	0.60	1.18	***-23***
China	912.4	3	***2.42***	4	7	***3.90***	6	6.15	92	0.58	1.60	***15***
India	314.1	11	1.77	3	16	2.61	4	5.87	97	0.56	1.47	1
Russia	277.4	13	***1.03***	-5	21	***1.23***	-4	4.87	112	0.46	1.19	***-16***
GCC countries												
Kuwait	6.2	66	1.21	-7	76	1.88	-4	5.27	106	0.50	1.55	6
Oman	3.3	83	1.34	-5	90	2.04	-3	5.09	108	0.48	1.52	1
Qatar	1.8	97	***3.30***	15	108	***10.32***	29	4.46	116	0.42	3.14	***44***
Saudi Arabia	21.6	48	1.89	-1	50	2.62	0	4.24	120	0.40	1.39	-1
UAE	7.0	65	1.91	3	72	***3.56***	8	5.32	104	0.50	1.86	***20***

Notes. 1. All types of scientific documents are taken into account.

2. In green bold text the most dynamic growth is shown in red bold text the least dynamic one.

Source: Author calculations from Essential Science Indicators database powered by Web of Science.

Publication activity (Scopus database)

Total number of scientific publications in Scopus (in `000)

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Change for 1998 – 2009 (%)	Std. dev. of growth rates for 1999 – 2009 (%)
BRIC countries														
Brazil	11.4	12.3	13.4	13.9	16.1	18.0	20.0	22.6	28.3	31.2	35.9	41.3	**262.3**	**5.5**
China	36.6	38.3	44.7	58.1	57.6	70.3	102.6	153.0	180.5	204.8	238.9	284.2	**676.5**	**15.3**
India	21.7	22.8	23.2	24.3	26.2	30.1	31.8	36.3	42.2	47.2	53.1	60.6	**179.3**	**5.0**
Russia	31.4	30.0	30.5	31.2	30.8	31.6	31.4	35.1	31.2	32.3	33.3	34.4	**9.6**	**5.7**
GCC countries														
Kuwait	0.6	0.7	0.6	0.6	0.6	0.6	0.7	0.8	0.8	0.9	1.0	1.0	**66.7**	**9.7**
Saudi Arabia	1.9	1.8	1.8	1.7	1.8	2.1	2.1	2.2	2.4	2.6	2.9	3.9	**105.3**	**11.3**

Note. All types of scientific documents of country in scientific journals indexed by Scopus was taken into analysis.
Source: Authors' calculations from the materials of SCImago Country and Journal Rank database (powered by Scopus).

Estimated[1,2] dynamics of number of scientific publications in Scopus per researcher

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Change for 1998 – 2009 (%)	Std. dev. of growth rates for 1999 – 2009 (%)
BRIC countries														
Brazil	0.21	0.19	0.18	0.18	0.20	0.20	0.20	0.21	0.24	0.25	0.27	0.30	**42.9**	**7.3**
China	0.08	0.07	0.06	0.08	0.07	0.08	0.11	0.14	0.15	0.14	0.15	0.18	**125.0**	**19.0**
India	0.18	0.20	0.20	0.19	0.19	0.22	0.22	0.23	0.30	0.33	0.36	0.41	**127.8**	**9.9**
Russia	0.06	0.06	0.06	0.06	0.06	0.06	0.07	0.08	0.07	0.07	0.07	0.08	**33.3**	**8.6**
GCC countries														
Kuwait	2.13	2.23	1.89	1.90	1.85	1.58	1.72	1.90	2.06	1.70	2.50	2.56	**20.2**	**17.8**
Saudi Arabia	1.89	1.49	1.53	1.41	1.22	1.64	1.76	1.97	2.14	2.55	2.44	3.01	**59.3**	**16.6**

Notes. 1. For Brazil, China, India and Saudi Arabia data on number of researchers was restored by method of extrapolation. Only for Russia and Kuwait we have real data, without extrapolation.
2. For Saudi Arabia data on number of researches are in head count representation, for all other country in full time equivalent representation.
3. All types of scientific documents of country in scientific journals indexed by Scopus was taken into analysis.
Source: Authors' calculations from the materials UNESCO Institute for Statistics Data Centre (Section "Science and technology") and SCImago Country and Journal Rank database (powered by Scopus).

High-tech export and production

Share of high-tech export as % of total export

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Change for 1998 – 2009 (%)	Std. dev. of growth rates for 1999 – 2009 (%)
BRIC countries																
Brazil	6.09	7.32	9.17	12.97	18.56	19.11	16.92	11.96	11.59	12.84	12.09	11.95	11.97	13.90	128.2	19.7
China	12.00	12.68	15.08	16.76	18.58	20.57	23.31	27.10	29.81	30.60	30.30	29.68	28.66	30.98	158.2	7.0
India	5.12	4.76	4.09	4.26	4.76	5.57	4.82	4.66	4.93	4.74	5.00	5.28	5.69	8.60	68.0	8.9
Russia	0.55	0.45	0.90	1.40	1.61	1.02	1.41	1.31	0.91	0.48	0.39	0.32	0.31	0.37	-32.7	39.8
GCC countries																
Kuwait	1.87	0.44	0.50	1.42	0.17	0.18	0.15	0.11	0.12		0.34	0.46	0.23		-87.7	71.4
Saudi Arabia	0.73		0.32	0.96	0.40	0.45	0.35	1.12	0.29	0.63	0.89	0.60	0.46	0.26	-64.4	98.5
UAE				1.11	0.69	1.93				1.80		1.20	3.24		191.9	122.9

Notes. 1. High-technology exports are products with high R&D intensity, such as in aerospace, computers, pharmaceuticals, scientific instruments, and electrical machinery.

Source: Authors' calculations from World Bank GEM (Global Econimic Monitor) database derived from United Nations Comtrade databases.

Share of high-tech and medium-tech production in GDP

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Change for 1998 – 2009 (%)	Std. dev. of growth rates for 1999 – 2009 (%)
Brazil	4.05	4.26	3.63	3.6	3.86	3.97	3.8	3.71	4.25	4.16	4.28	4.64	4.77	4.99	5.24	29.4	6.8
China	13.61	13.77	13.32	13.24	13.73	13.45	13.63	14.17	13.94	13.93	14.21	14.3	13.74	14.08	14.4	5.8	2.3
India	5.3	4.76	4.62	4.54	4.8	4.73	4.79	4.81	5.04	5.43	5.57	5.53	5.34	5.31	5.59	5.5	4.4
Russia		4.83	4.84	4.87	5.02	4.84	4.95	4.71	4.66	4.35	4.11	4.13	4.53	3.7	4.26	-11.8	4.3
Kuwait					0.5	0.52	1.39	1.28	1.63	1.41	1.14	1.24	1.09	1.39	1.47	194.0	54.8

Notes. 1. In high- and medium-tech production here are included the following:

a) GDP from Manufacture of Chemicals, Chemical Products and Man-Made Fibers;

b) GDP from Manufacture of Machinery and Equipment;

c) GDP from Manufacture of Electrical and Optical Equipment;

d) GDP from Manufacture of Transport Equipment.

Source: Authors` calculations from Euromonitor Global Market Information Database (Section "Government, Labour and Education") derived from national.

Global Competitiveness Index: some basics

Global Competitiveness Report (GCR) - yearly report published by the World Economic Forum. The 2011–2012 report covers 142 countries

Global Competitiveness Index integrates the macroeconomic and the micro/business aspects of competitiveness into a single index

It is made up of over 110 variables:
- two thirds from the Executive Opinion Survey (13.5 ths. Respondents in 142 countries in 2011)
- one third from publicly available sources such as the United Nations statistical database, World Bank and so on.

The variables are organized into twelve pillars, with each pillar representing an area considered as an important determinant of competitiveness

I. Basic requirements	II. Efficiency enhancers	III. Innovation and sophistication factors
1st pillar Institutions	5th pillar Higher education and training	11th pillar Business sophistications
2nd pillar Infrastructure	6th pillar Goods market efficiency	12th pillar Innovation
3rd pillar Macroeconomic environment	7th pillar Labour market efficiency	
4th pillar Health and primary education	8th pillar Financial market development	
	9th pillar Technological readiness	
	10th pillar Market size	

Global Competitiveness Index 12th Pillar "Innovation": some basics

GCI 12th pillar Innovation is organized as follows:

Estimates of 12th Pillar range from 1 (worst) to 7 (best)

12th pillar consists of 8 sub-pillars: first seven sub-pillars are based on the results of the Executive Opinion Survey (estimates from 1 to 7) and the last one is the absolute number of utility patents

Sub-pillars of 12th Pillar "innovation" of GCI are the following:

1. Availability of scientists and engineers: To what extent are scientists and engineers available in your country? [1 = not at all; 7 = widely available]

2. Capacity for innovation: In your country, how do companies obtain technology? [1 = exclusively from licensing or imitating foreign companies; 7 = by conducting formal research and pioneering their own new products and processes]

3. Company spending on R&D: To what extent do companies in your country spend on R&D? [1 = do not spend on R&D; 7 = spend heavily on R&D]

4. Government procurement of advanced tech products: Do government procurement decisions foster technological innovation in your country? [1 = no, not at all; 7 = yes, extremely effectively]

5. Intellectual property protection: How would you rate intellectual property protection, including anti-counterfeiting measures, in your country? [1 = very weak; 7 = very strong]

6. Quality of scientific research institutions: How would you assess the quality of scientific research institutions in your country? [1 = very poor; 7 = the best in their field internationally]

7. University-industry collaboration in R&D: To what extent do business and universities collaborate on research and development (R&D) in your country? [1 = do not collaborate at all; 7 = collaborate extensively]

8. Utility patents granted: Number of utility patents (i.e., patents for invention) granted in 2010, per million population

Strengths and weaknesses of national innovation systems of BRIC and GCC countries

	Strong sides	Weak sides
Brazil	Quality of scientific research institutions; Availability of scientists and engineers; Capacity for innovation	Government procurement of advanced tech products; Intellectual property protection; Company spending on R&D
China	University-industry collaboration in R&D; Government procurement of advanced tech products; Capacity for innovation	Quality of scientific research institutions; Availability of scientists and engineers
India	Quality of scientific research institutions; Availability of scientists and engineers	Government procurement of advanced tech products; University-industry collaboration in R&D
Russian Federation	Quality of scientific research institutions; Availability of scientists and engineers	Government procurement of advanced tech products; Intellectual property protection; Capacity for innovation; University-industry collaboration in R&D
BRIC countries	**Quality of scientific research institutions; Availability of scientists and engineers**	**Intellectual property protection; University-industry collaboration in R&D**
Bahrain	Government procurement of advanced tech products; Intellectual property protection	Capacity for innovation; Company spending on R&D; Quality of scientific research institutions
Kuwait	Availability of scientists and engineers; Intellectual property protection; Quality of scientific research institutions	Capacity for innovation; University-industry collaboration in R&D; Company spending on R&D
Oman	Government procurement of advanced tech products; Intellectual property protection	Availability of scientists and engineers
Qatar	Government procurement of advanced tech products; Intellectual property protection	Company spending on R&D
Saudi Arabia	Government procurement of advanced tech products; Availability of scientists and engineers	Capacity for innovation; University-industry collaboration in R&D
United Arab Emirates	Government procurement of advanced tech products; Intellectual property protection	Capacity for innovation; University-industry collaboration in R&D
Middle East and North Africa	**Government procurement of advanced tech products; Intellectual property protection**	**Capacity for innovation; Company spending on R&D; University-industry collaboration in R&D**

Notes. Authors assessment on the basis of Global Competitiveness Index (GCI index) 12th pillar “Innovation” index.

Conclusions (for individual countries)

Country-level conclusions from analysis

The success of BRIC countries evidently correlates with the focus on technology development and the ability to apply its results.

China is a good example where both seem to work very well

Brazil and India seem to stagnate somewhat and should further push on the commenced initiatives

Russia has fallen behind and needs to completely rebuild its innovation position in the world

Saudi Arabia and UAE have shown relatively high progress in innovation without major R&D investments

Kuwait has not been able to do equally well in the past years

Challenges for future development of national innovation system:

-for Russia – overcoming long-lasting stagnation in all basic input and output parameters of NIS development; ensuring attractiveness of R&D sector for business; attracting new human capital into R&D sector

- for China – sustaining the fast speed of output indicators of NIS development and making appropriate financial provision for this development

- for India – fostering R&D investments; stimulating in-country patent activity; fostering high-tech export

- for Brazil – fostering R&D investments and stimulating resident in-country patent activity as well as international patent activity

- for GCC countries – increasing investments in R&D seriously, creation of instructional base of national innovation system; attracting business and higher education sector in performance of R&D, massive attracting of human capital into R&D sector

Conclusions (general)

BRIC and GCC countries are facing the challenges of enhancing their national innovation systems

In general BRIC and GCC countries are to build knowledge driven economies

They still need to emphasize the real economy considering the service knowledge based economy a sustainable real value creating economy

GCC and BRIC need to find their own path for national development

Furthermore there is a need to convert the industry culture and influence towards a more open attitude towards open science and open innovation

Thank you for your attention!

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