

Knowledge flows and capabilities in the Brazilian research system 2005-2009 – Bibliometric assessment

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Background: Knowledge and development

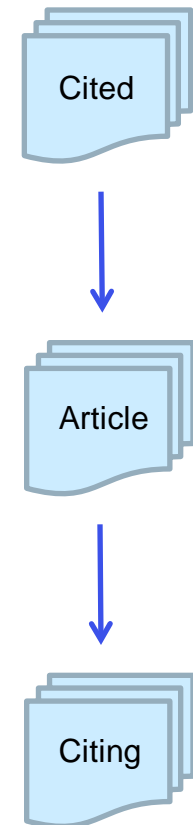
- ❑ Comparative perspectives on knowledge and development
 - ❑ Towards policy strategies and conceptual framework that supports build-up of innovation systems in developing countries
 - ❑ Brazil is in many aspects "the model country" for knowledge driven development;
 - ❑ Move towards knowledge driven economy;
 - ❑ Poverty reduction success in the 2000s;
 - ❑ Technological leadership in many industries ;
 - ❑ Long run tradition in building excellence in fundamental science;
 - ❑ Institutional set-up of the society;
- ❑ Dependency on foreign knowledge production vs. build-up of domestic capacities
- ❑ How Brazilian is Brazilian science?
 - ❑ Can we identify the emergence of genuinely Brazilian clusters of knowledge?
 - ❑ Is there overly dependencies on foreign knowledge bases?
 - ❑ What are the clusters of knowledge in Brazil (SP / South / Minas Gerais)
- ❑ Why science – does it matter for development or innovation?
 - ❑ Our belief: Without core capabilities in fundamental science, country is confined to "use" instead of "entry" in the scientific and technological domain.

Research in Brazil – Assumptions, questions and hypothesis

- ❑ What roles foreign and domestic capacities play for the expansion of knowledge production?
 - ❑ *Does Brazilian research become more relevant for Brazilian research in 2005-2009*
 - ❑ *What global STI trends contribute to / follow from the rise of Brazilian research?*
- ❑ Description of the nature of expansion process of the Brazilian research system:
 - ❑ Geographic dimensions (domestic / global)
 - ❑ Distribution of research excellence
 - ❑ Knowledge in- and outflows
- ❑ How does this analysis compare with other emerging & developing countries?
- ❑ What can we learn about the evolution of innovation systems?

Citations as knowledge in- and outflows

- ❑ Citations as acknowledgements of theoretical and empirical framework and base: *intellectual ties*;
- ❑ Social characteristics of citations as *social ties*;
- ❑ Citations received and citations made
 - ❑ References and their characteristics as a of knowledge base for articles;
 - ❑ Geography of knowledge base;
 - ❑ Characteristics of excellence;
 - ❑ Sources of relevant research;
 - ❑ Change over time;
 - ❑ Transformation dynamics of the Brazilian system;
- ❑ For this paper:
 - ❑ Geographical origin of citations as a property of Brazilian research output;
 - ❑ Text as the unit of analysis, not author;



Data

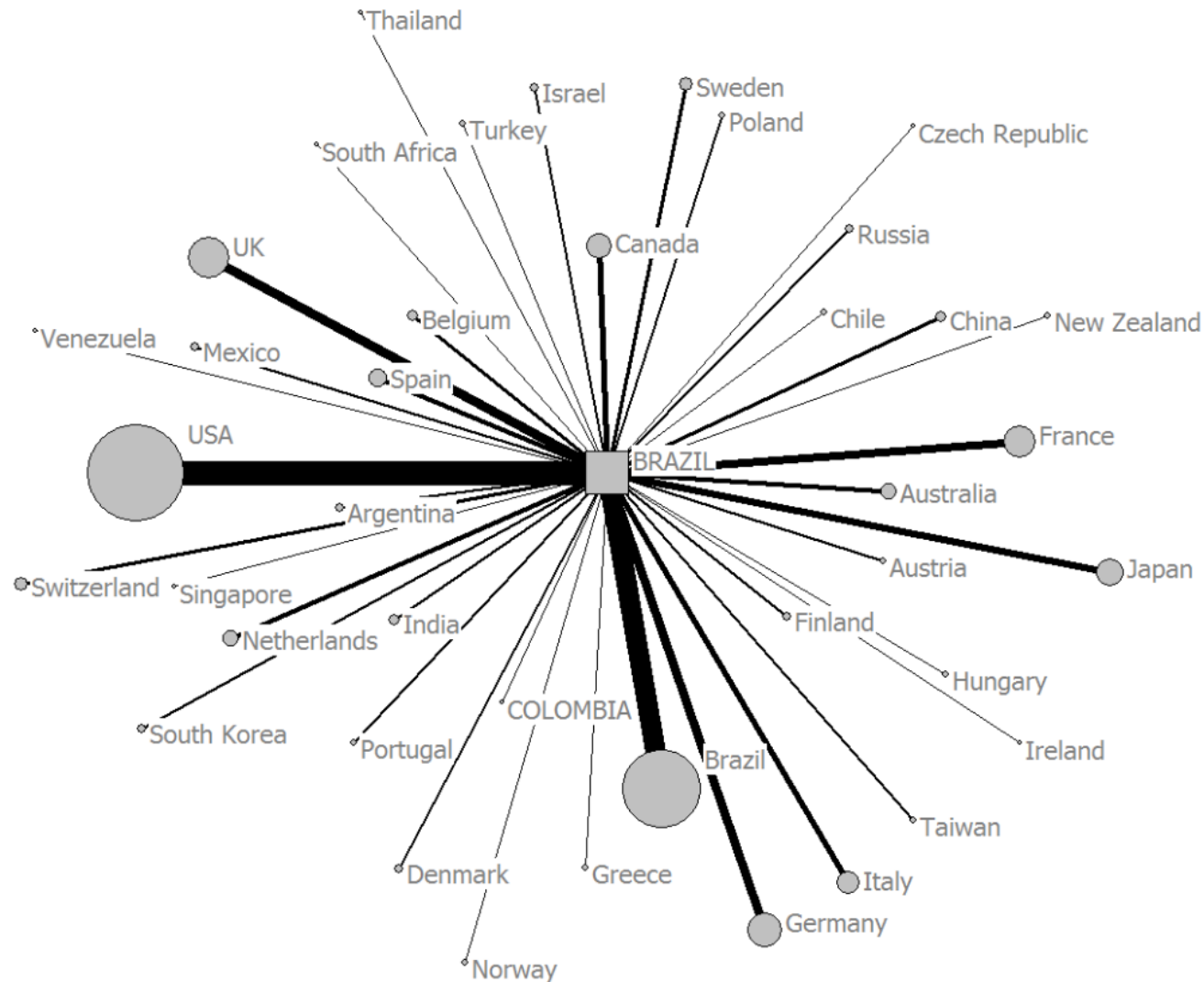
- ❑ Custom data from Thomsom Reuters: Institute for Scientific Information (ISI) papers with at least one Brazilian research address from years 2005-2009, forming SOURCE data set;
 - ❑ Complete article level information in XML format;
- ❑ Total number of papers: **152,031**. For this paper, only articles and proceedings were included, totalling **127,826**.
- ❑ In addition, two other data sets:
 - ❑ CITED: All papers cited by papers in SOURCE pages;
 - ❑ CITING: All papers making citations to SOURCE papers;
 - ❑ Unique identifier linking CITED, SOURCE and CITING papers;
 - ❑ Note: not ISI indexed citation references not included in data;
- ❑ Linking CITED papers: we included only references within the last ten years of publication of paper: for 2005 papers, we included only references from 1995-2005 and for 2009 papers only 1999-2009, etc.
- ❑ Linking CITING papers, we included whole data.
- ❑ Added Brazilian state-level research address to 25,000 papers in SOURCE data, increasing its coverage to 98% of all papers;
- ❑ For processing data, we used VantagePoint and to make network maps, UCInet.

	STATE	PAPERS	Growth 05-09	Share of BR papers	Cumulative Share
1	SP	59435	57,94 %	38,39 %	38,39 %
2	RJ	20944	56,36 %	13,53 %	51,92 %
3	MG	14869	107,95 %	9,61 %	61,53 %
4	RS	13977	95,89 %	9,03 %	70,56 %
5	PR	8987	107,29 %	5,81 %	76,36 %
6	DF	5755	68,24 %	3,72 %	80,08 %
7	SC	5223	88,54 %	3,37 %	83,45 %
8	PE	4436	106,24 %	2,87 %	86,32 %
9	BA	3501	87,55 %	2,26 %	88,58 %
10	CE	3245	93,81 %	2,10 %	90,68 %
11	PB	2345	146,60 %	1,51 %	92,19 %
12	GO	1886	118,36 %	1,22 %	93,41 %
13	RN	1842	96,09 %	1,19 %	94,60 %
14	PA	1764	94,92 %	1,14 %	95,74 %
15	AM	1282	124,85 %	0,83 %	96,57 %
16	ES	1099	179,84 %	0,71 %	97,28 %
17	MS	1009	256,99 %	0,65 %	97,93 %
18	MT	646	296,83 %	0,42 %	98,35 %
19	SE	525	228,26 %	0,34 %	98,69 %
20	AL	509	211,11 %	0,33 %	99,02 %
21	MA	502	207,69 %	0,32 %	99,34 %
22	PI	353	243,33 %	0,23 %	99,57 %
23	TO	201	428,57 %	0,13 %	99,70 %
24	RO	178	55,17 %	0,11 %	99,81 %
25	AC	139	366,67 %	0,09 %	99,90 %
26	RR	99	163,64 %	0,06 %	99,97 %
27	AP	51	183,33 %	0,03 %	100,00 %

Brazilian research 2005-2009

- ❑ Papers and articles increased from 2005 to 2009 70%
 - ❑ Papers 2005: 18,619
 - ❑ Papers 2009: 31,674
- ❑ São Paulo captures about 40% of all papers; followed by RJ, MG and RS.
- ❑ Growth is highly uneven:
 - ❑ Catch-up states MR and RS have about 100% over 05-09;
 - ❑ SP and RJ about 55%;
- ❑ Small research states show high growth rates;
- ❑ Brazilian research system is getting more balanced with increasing number of centers;

Network of cited papers by Brazilian research - 2005



N for Brazilian articles and proceedings in 2005=18619; N for cited papers=238418;

*Cited papers limited to publications from 1995-2005. **Note:** Scale for strength of ties is 1-20 and based on occurrence of citations. Scale for node size is 2-20 and based on all papers from the country, except for the square Brazil, whose size is based on publications in 2005.

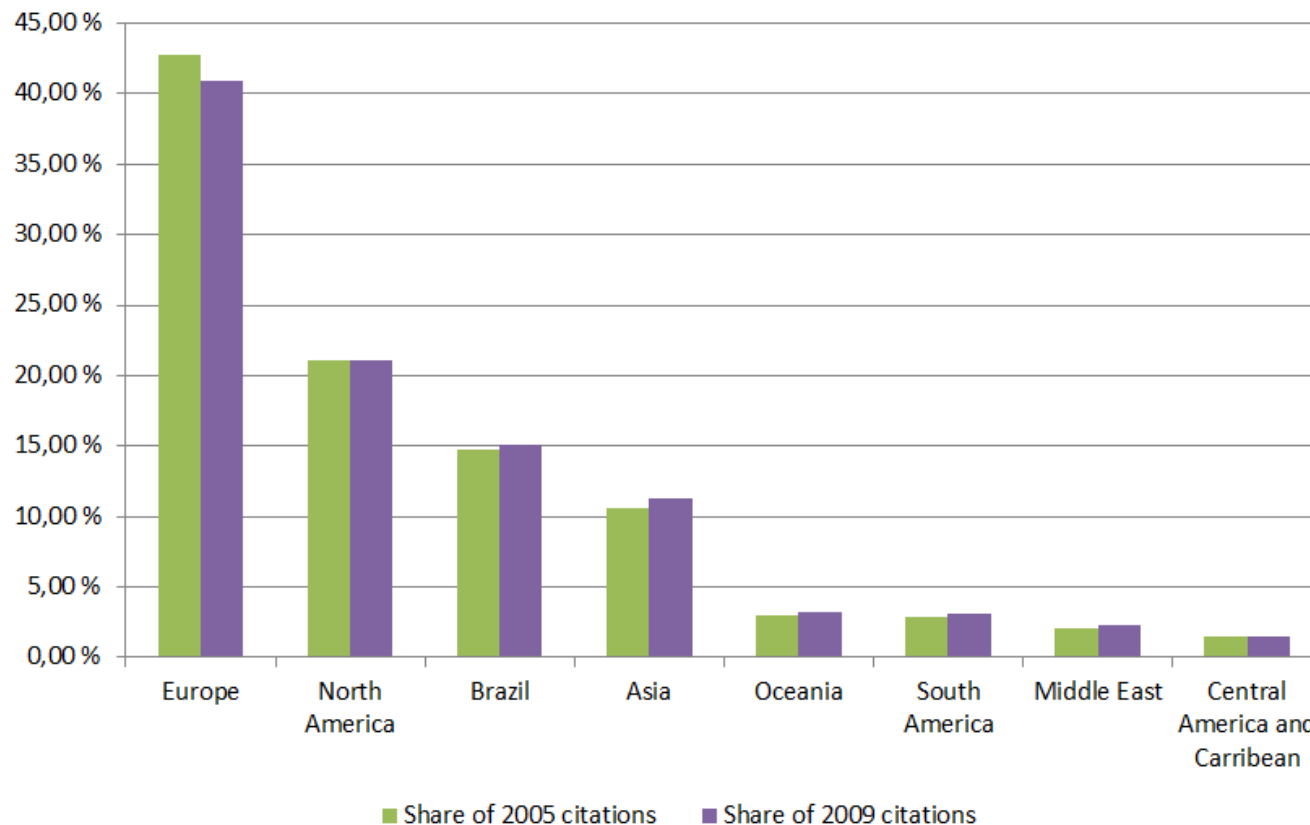
Top-20 source countries for citations made in Brazilian research 05-09

Rank*	Cited RS Country	% of Cited 2005	% of Cited 2006	% of Cited 2007	% of Cited 2008	% of Cited 2009	% of total cited 2005-2009	Total cited 2005-2009	Cumulative share 2005-2009	% change in share 2005-2009
	TOTAL	100,00 %	100,00 %	100,00 %	100,00 %	100,00 %	100,00 %	1861426	NA	NA
1	USA	17,21 %	16,92 %	17,43 %	17,50 %	17,42 %	17,33 %	322530	17,33 %	1,26 %
2	Brazil	14,77 %	14,88 %	14,30 %	14,73 %	15,13 %	14,78 %	275034	32,10 %	2,45 %
3	UK	7,14 %	7,12 %	7,42 %	7,20 %	7,07 %	7,19 %	133803	39,29 %	-0,98 %
4	Germany	5,87 %	5,79 %	5,82 %	5,57 %	5,41 %	5,66 %	105279	44,95 %	-7,79 %
5	France	5,54 %	5,35 %	5,21 %	5,02 %	4,84 %	5,14 %	95651	50,09 %	-12,69 %
6	Japan	4,35 %	4,27 %	4,22 %	3,98 %	3,88 %	4,10 %	76339	54,19 %	-10,78 %
7	Italy	3,86 %	3,88 %	3,87 %	3,80 %	3,63 %	3,79 %	70570	57,98 %	-5,94 %
8	Canada	3,92 %	3,73 %	3,77 %	3,71 %	3,69 %	3,75 %	69754	61,72 %	-6,02 %
9	Spain	3,05 %	3,11 %	3,15 %	3,20 %	3,24 %	3,16 %	58885	64,89 %	6,06 %
10	Australia	2,50 %	2,47 %	2,55 %	2,67 %	2,68 %	2,59 %	48217	67,48 %	6,91 %
11	Netherlands	2,46 %	2,51 %	2,44 %	2,43 %	2,45 %	2,46 %	45708	69,93 %	-0,70 %
12	China	1,71 %	1,83 %	1,98 %	2,10 %	2,31 %	2,03 %	37781	71,96 %	34,97 %
13	Switzerland	2,03 %	2,07 %	1,98 %	1,96 %	1,96 %	1,99 %	37035	73,95 %	-3,87 %
14	Sweden	1,90 %	1,85 %	1,81 %	1,84 %	1,78 %	1,83 %	34057	75,78 %	-6,35 %
15	India	1,46 %	1,60 %	1,60 %	1,60 %	1,73 %	1,62 %	30102	77,40 %	18,47 %
16	Belgium	1,54 %	1,52 %	1,49 %	1,53 %	1,48 %	1,51 %	28097	78,91 %	-3,41 %
17	Argentina	1,23 %	1,24 %	1,20 %	1,22 %	1,29 %	1,24 %	23006	80,15 %	4,80 %
18	South Korea	1,10 %	1,14 %	1,11 %	1,16 %	1,18 %	1,14 %	21309	81,29 %	7,53 %
19	Denmark	1,08 %	1,12 %	1,14 %	1,09 %	1,10 %	1,11 %	20595	82,40 %	2,28 %
20	Israel	1,14 %	1,09 %	1,09 %	1,01 %	0,99 %	1,05 %	19568	83,45 %	-12,95 %

Top-20 source countries for citations received for BR research 05-09

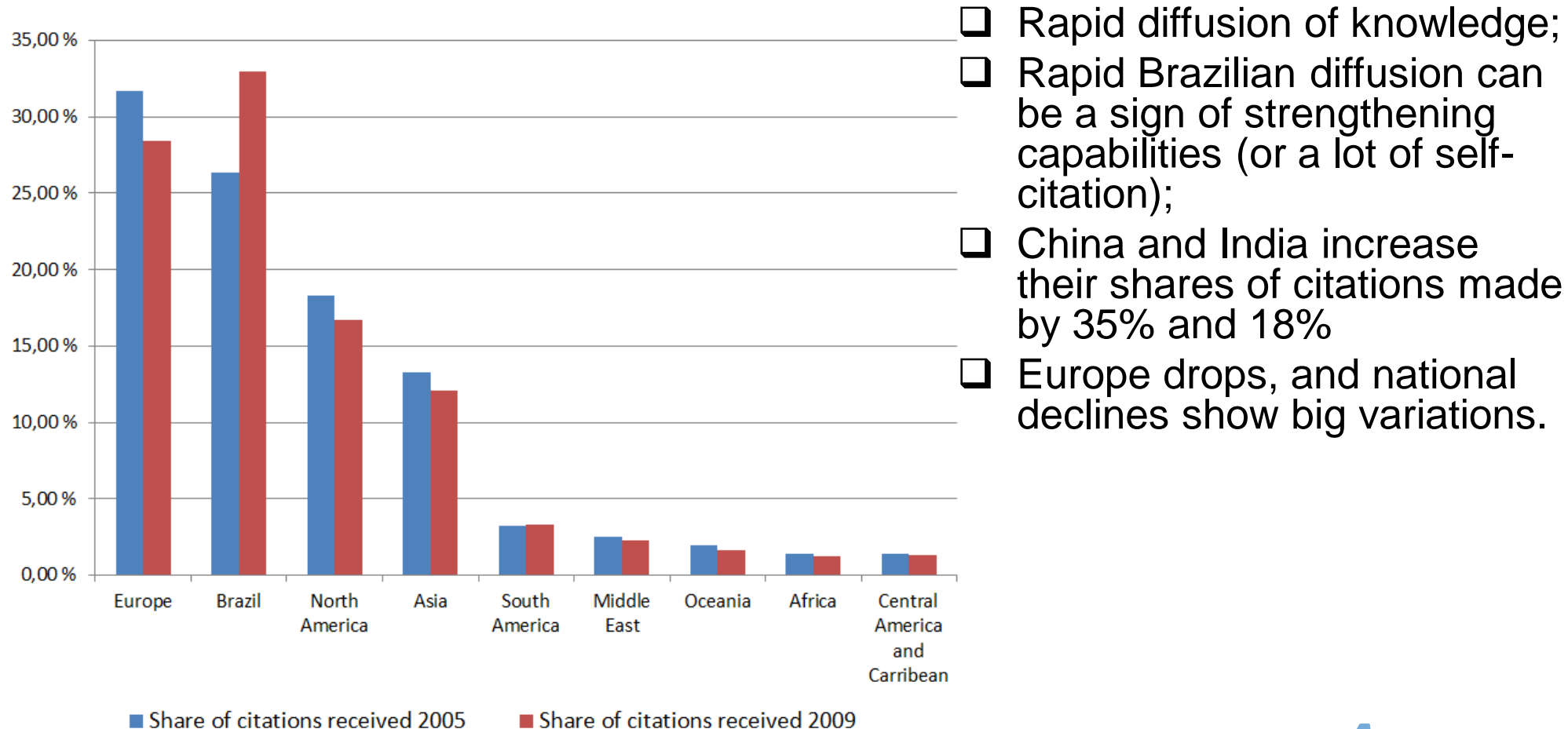
Rank*	Country	% of citations received 2005	% of citations received 2006	% of citations received 2007	% of citations received 2008	% of citations received 2009	Cumulative share 2005	% change 2005-2009
1	Brazil	26,30 %	34,88 %	36,29 %	38,64 %	41,67 %	26,30 %	58,43 %
2	USA	16,03 %	13,57 %	13,47 %	12,61 %	11,59 %	42,33 %	-27,72 %
3	China	5,33 %	4,28 %	4,10 %	3,89 %	3,44 %	47,67 %	-35,58 %
4	Germany	4,70 %	4,10 %	4,00 %	4,01 %	3,57 %	52,37 %	-24,06 %
5	UK	4,41 %	3,74 %	3,85 %	3,70 %	3,53 %	56,78 %	-20,02 %
6	France	4,05 %	3,61 %	3,69 %	3,61 %	3,39 %	60,83 %	-16,39 %
7	Italy	3,13 %	2,70 %	2,61 %	2,37 %	2,31 %	63,97 %	-26,26 %
8	Spain	3,11 %	2,62 %	2,70 %	2,91 %	3,19 %	67,08 %	2,28 %
9	Japan	2,79 %	2,20 %	2,09 %	1,81 %	1,47 %	69,87 %	-47,23 %
10	Canada	2,54 %	2,20 %	2,17 %	2,03 %	2,13 %	72,41 %	-16,13 %
11	India	1,85 %	1,62 %	1,49 %	1,39 %	1,37 %	74,26 %	-25,92 %
12	Australia	1,64 %	1,34 %	1,30 %	1,24 %	1,14 %	75,90 %	-30,39 %
13	Netherlands	1,41 %	1,27 %	1,20 %	1,27 %	1,24 %	77,31 %	-11,94 %
14	South Korea	1,41 %	1,20 %	1,16 %	1,16 %	0,89 %	78,73 %	-36,86 %
15	Switzerland	1,29 %	1,03 %	1,05 %	1,04 %	1,35 %	80,01 %	5,09 %
16	Argentina	1,28 %	1,50 %	1,40 %	1,50 %	1,17 %	81,30 %	-8,96 %
17	Belgium	1,03 %	0,82 %	0,83 %	0,74 %	0,89 %	82,32 %	-13,78 %
18	Sweden	1,02 %	0,98 %	0,92 %	0,89 %	0,85 %	83,34 %	-17,00 %
19	Russia	0,99 %	1,02 %	0,96 %	0,95 %	0,73 %	84,34 %	-26,70 %
20	Turkey	0,99 %	0,84 %	0,69 %	0,61 %	0,48 %	85,33 %	-51,85 %
NA	TOTAL	285087	192297	151693	87709	17611	NA	

Papers cited by Brazilian research by origin – Major regions 2005 and 2009

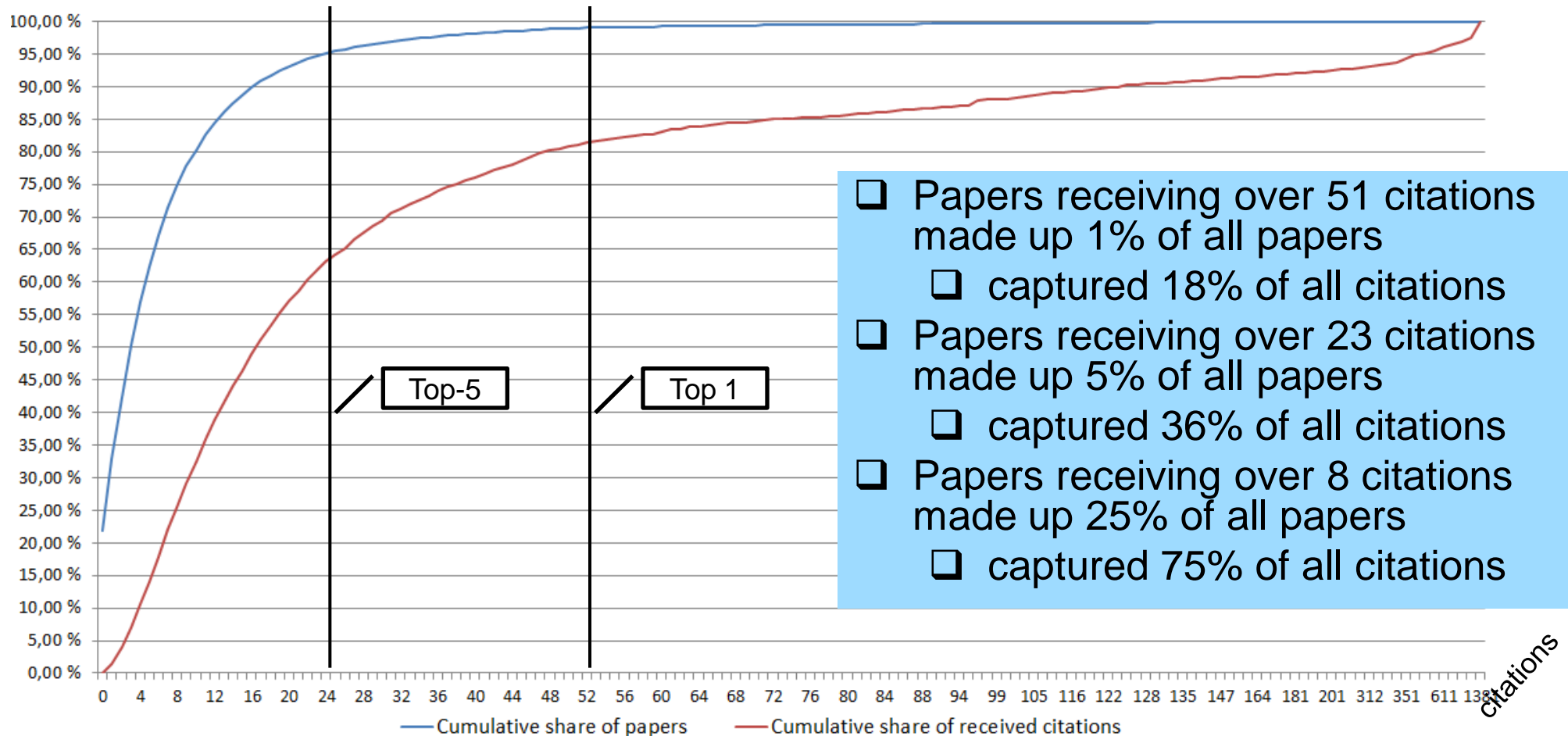


- ❑ Relevance geographical knowledge bases for Brazilian research
- ❑ Brazil is relying increasingly on domestic knowledge base in research production – albeit with only small increases;
- ❑ The US increases its share too, whereas Canada declines;
- ❑ China and India increase their shares of citations by 35% and 18%
- ❑ Europe drops, and national declines show big variations

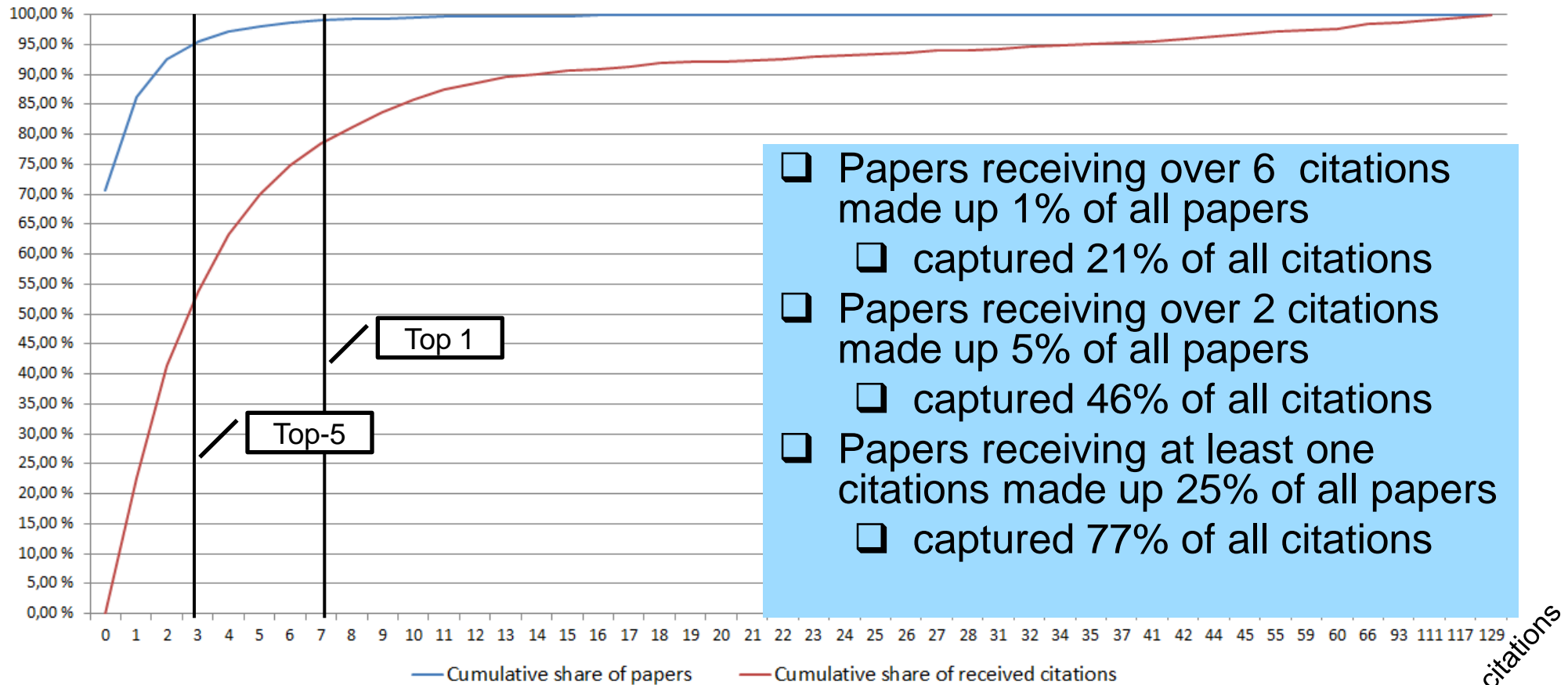
Citations received BR 2005 and 2009 papers by Major regions



Cumulative %-share of papers and received citations by number of received citations – 2005



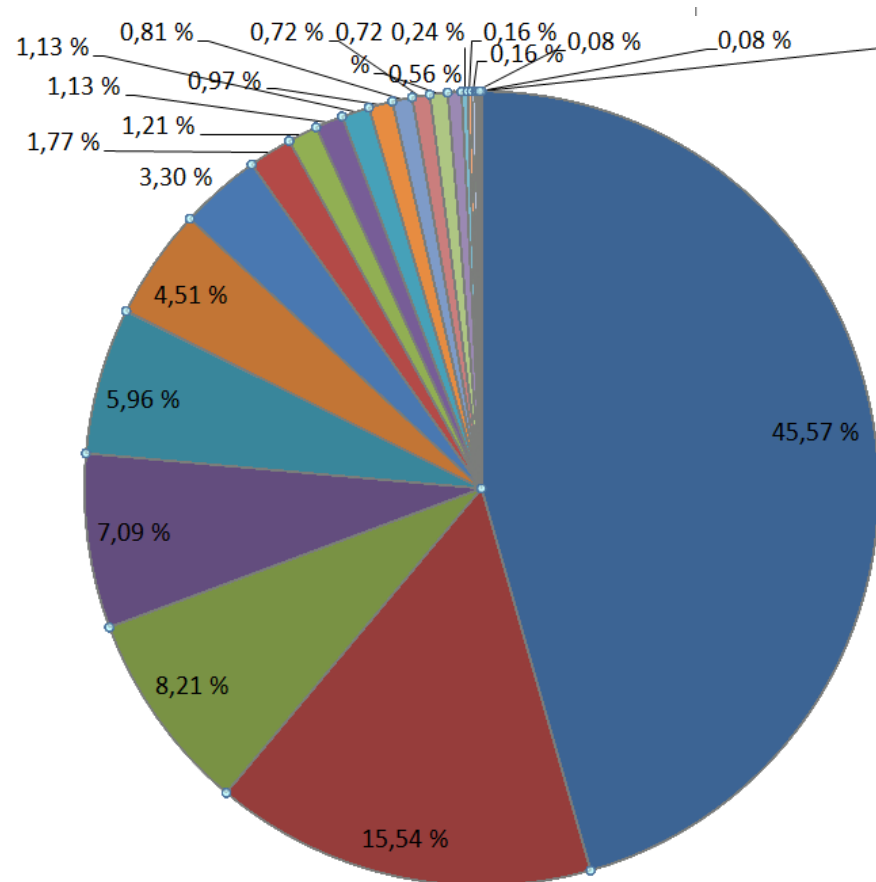
Cumulative share of papers and received citations – 2009



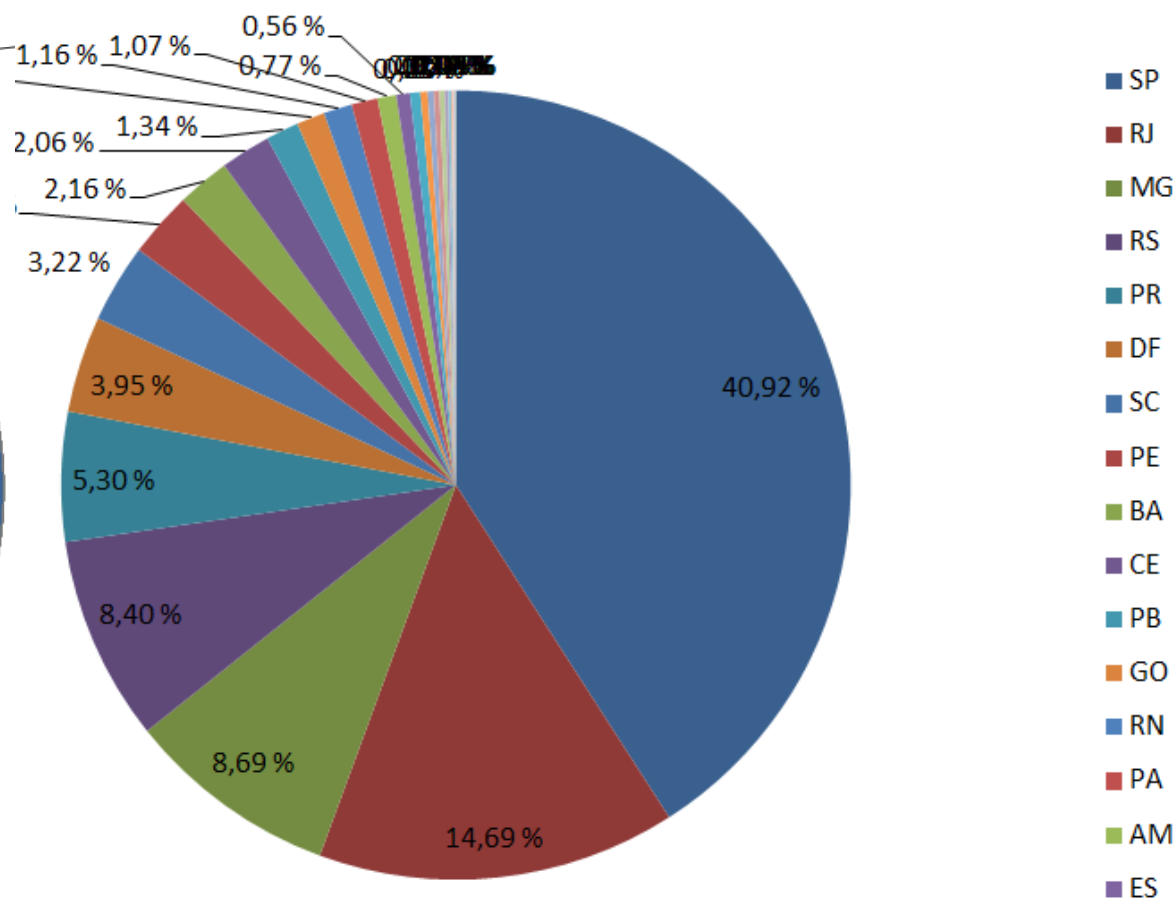
- ❑ Papers receiving over 6 citations made up 1% of all papers
 - ❑ captured 21% of all citations
- ❑ Papers receiving over 2 citations made up 5% of all papers
 - ❑ captured 46% of all citations
- ❑ Papers receiving at least one citations made up 25% of all papers
 - ❑ captured 77% of all citations

State share of all papers and top-1% papers, 2005

Top1%



All



- SP
- RJ
- MG
- RS
- PR
- DF
- SC
- PE
- BA
- CE
- PB
- GO
- RN
- PA
- AM
- ES

State share of top-1% and 5% papers, 2005-2009

Top-5% cited papers 2005-2009

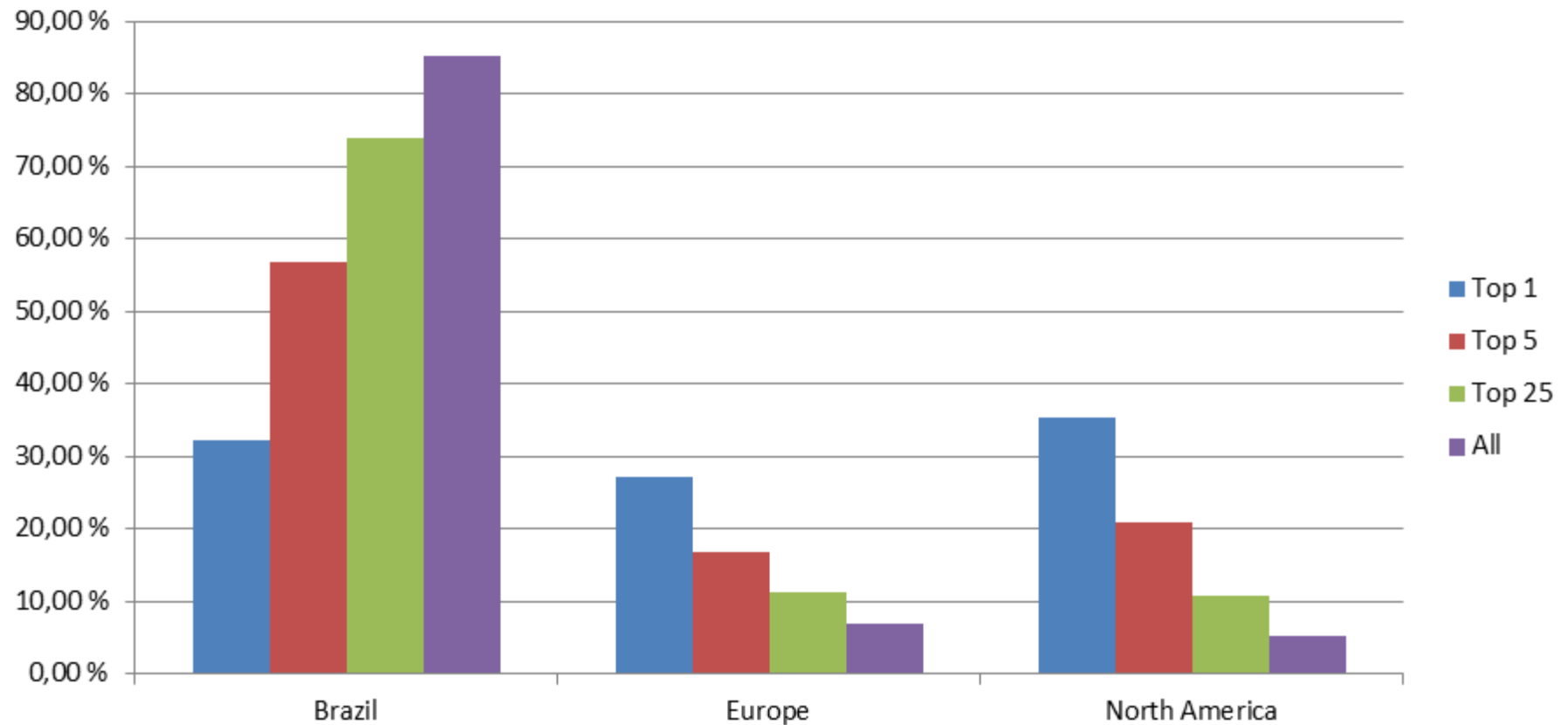
Rank	States	Records 2005	Records 2007	Records 2009	Share 2005	Share 2007	Share 2009	% Change 05-09
1	SP	566	782	1251	45,57 %	44,16 %	42,25 %	-7,29 %
2	RJ	193	242	436	15,54 %	13,66 %	14,72 %	-5,24 %
3	RS	102	183	263	8,21 %	10,33 %	8,88 %	8,15 %
4	MG	88	130	247	7,09 %	7,34 %	8,34 %	17,73 %
5	DF	74	99	166	5,96 %	5,59 %	5,61 %	-5,91 %
6	PR	56	73	122	4,51 %	4,12 %	4,12 %	-8,62 %

- ☐ Widening space of research excellence;
- ☐ Diverging paths of growth and excellence at state levels

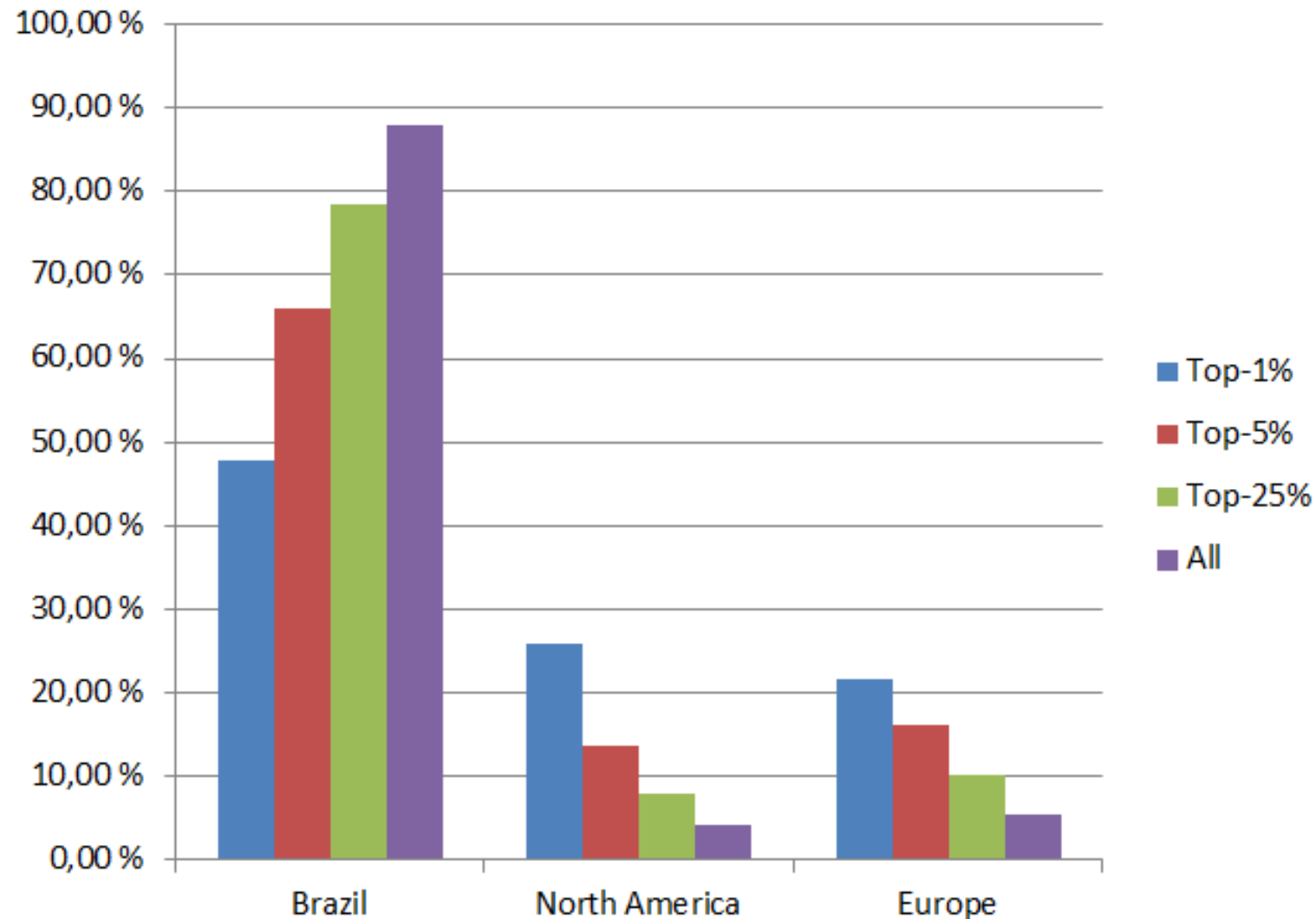
Top-1% cited papers 2005-2009

	State	Records 2005	Records 2007	Records 2009	Share 2005	Share 2007	Share 2009	% Change 05-09
1	SP	115	145	250	46,18 %	44,07 %	44,96 %	-2,64 %
2	RJ	30	55	85	12,05 %	16,72 %	15,29 %	26,89 %
3	DF	22	23	32	8,84 %	6,99 %	5,76 %	-34,86 %
4	RS	22	33	40	8,84 %	10,03 %	7,19 %	-18,57 %
5	MG	16	23	40	6,43 %	6,99 %	7,19 %	11,96 %
6	PR	13	13	22	5,22 %	3,95 %	3,96 %	-24,21 %

Share of reprint addresses in 2005 Brazilian papers



Share of reprint addresses in 2009 Brazilian papers



Conclusions

- ❑ Brazilian knowledge base is key element for Brazilian research, and probably in increasing manner;
- ❑ Growth of the Brazilian research system is accompanied by geographical transformation;
- ❑ Relevance of foreign knowledge bases: US research remains relevant for Brazil; EU declines, and South-South (esp. China) increase their relevance quickly;
- ❑ Brazilian research is highly Brazilian - Brazil controls sizeable share of re-print addresses
- ❑ Foreign research matters a lot for quality – Share of BR Reprinting addresses is inverse to number of citations
- ❑ *Volume doesn't match quality* when you contrast Brazilian and foreign research;
- ❑ *Volume does match quality* when you look only BR research;

THANK YOU!

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