The different flavours of research collaboration: a case study of their influence on university excellence in four world regions

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Abstract This study on research collaboration (RC) is an attempt to estimate the degree of internationalization of academic institutions and regions. Furthermore potential influences of RC on excellence initiatives of modern universities are investigated relying on source data obtained from *SCImago Institutions Rankings (SIR)*.
A positive correlation exists between the degree of collaboration and the normalized impact. However, in contrast to output the normalized impact increase progression is non-linear and fluctuating.
Differences occur regarding output volume and normalized impact at geographical region level for the leading universities. Different patterns of the Brute Force distribution for each collaboration type were are also observed at region level as well as at subject area level.
A continuously reduced percentage of the domestic (non-collaboration) academic output is a world trend, whereas a steady increase of "international + national" collaboration is observed globally, however, less distinctive in Asia than in the other regions.
The impact of Latin American papers originating from domestic production as well as from national collaboration remains considerably below world average values.

Introduction

Within the last decades knowledge production underwent radical changes. Research collaboration (RC) has become a necessity due to the enormous pressure scientists, institutions or even countries face in their daily struggles to meet the required publication output requirements. Thus the number of internationally co-authored papers is abruptly increasing, and an intensification of RC is reported at all aggregation levels (Narin et al. 1991; Katz and Martin, 1997; Katz and Hicks 1997; Glänzel et al., 1999; Glänzel, 2001). However, differences still exist among research fields regarding volume and impact of collaboration (Glänzel and Schubert, 2001). There is an increase of international scientific collaboration (ISC) in the emergent disciplines, where knowledge sharing needs to be most efficient (Heinze and Kuhlmann, 2008).

Several studies have also pointed out that multiple authorship produces an increase in citations as a positive side effect of RC (Leimu and Koricheva, 2005; Hsu and Huang, 2011; Hsiang Liao, 2011). Other findings only suggest a weak correlation between international papers and "highly-cited papers" except for small countries (Van Leuwen and Tijssen 2007; Glänzel and Schubert, 2001; Persson, 2010). This indicates that one should be cautious about extrapolating findings from one country to another (Glänzel et al., 1999), and even from one region to another region (Levitt and Thelwall, 2010).

Beyond doubt, influence on research impact certainly depends on the type of collaboration (Sooryamoorthy, 2009), however, not all types of collaboration have the same effect on research impact in terms of citations (Bordons et al., 1996; Lee et al., 2001; Persson et al., 2004; Gazni and Didegah, 2011; Gorraiz et al., 2011).

Our study on RC is an attempt to estimate the degree of internationalization of academic institutions and regions. Furthermore potential influences of RC on excellence initiatives of modern universities shall be investigated.

This paper is organised as follows: first, the objectives and the underlying questions to be addressed are described. Second, the sources, the units of analysis and the indicators used in this study are specified. Third, the results are presented. Finally, the findings are summarized and directions for future research are concluded.

Objectives

Our study aims to analyse the effect of different types of collaboration (international, international + national, national, or none) on the citation impact of the research output from four selected geographical regions. Each region is represented by its ten most excellent universities.

The underlying questions are:
1) What are the proportions of the different collaboration types?
2) What is the estimated amount and impact of papers without collaboration (domestic)?
3) What is the trend in the different types of collaboration?
4) Does this trend differ from region to region?
5) Can evident discrepancies be observed across the six selected subject areas?
6) Are the degrees of collaboration and impact somehow correlated at the analysed universities?

Methodology

Source data

This analysis relies on source data obtained from *SCImago Institutions Rankings (SIR). SCImago Institutions Rankings (SIR)* is a science evaluation resource to assess universities and research-focused institutions worldwide, based on Scopus (Elsevier B.V.) data.

Units of Analysis: Regions, Excellence Universities and Subject Areas

The focus of the study is Latin America (incl. the Caribbean countries). Results are compared with the two leading regions, Northern America and Western Europe. Furthermore, the Asiatic Region has been included due to its "research emergence" character for complementary reasons.

"Excellence" Universities* were determined according to the following selection criteria:

- in a first step the 50 most productive (regarding research output) universities were selected per geographical region
- in a second step the top 10 universities were determined according to the normalized impact

Almost 1 million (929.353)[1] publications were retrieved. Figure 1 shows the regional distribution of the data retrieved for this study.

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[1] This number represents the sum of all publications calculated in SCImago Institutions Rankings (SIR) from each university's contribution and does not consider any overlaps originating from joint publications.
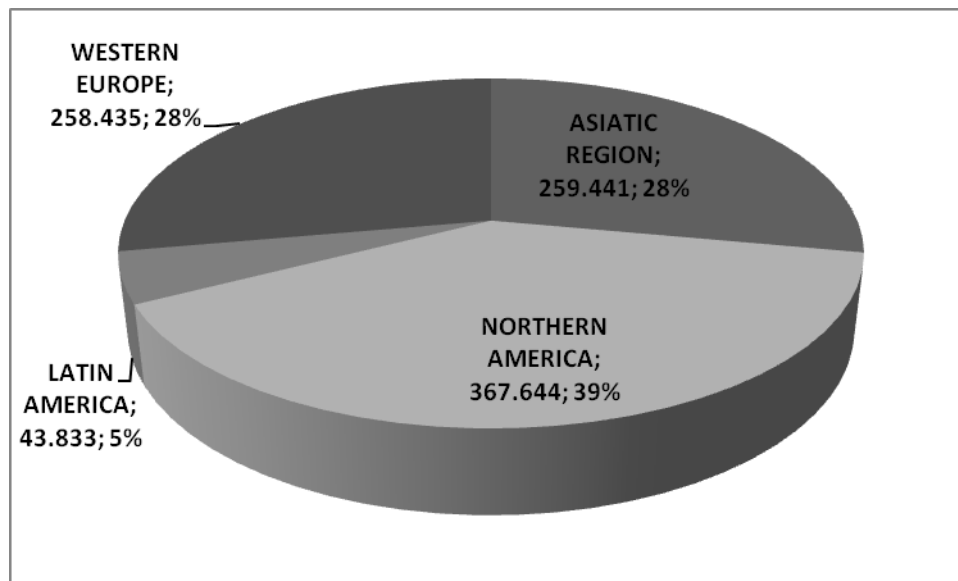
Fig. 1 Regional distribution of the data

Following 6 subject areas (as defined in Scopus) were chosen in order to represent all parts of the global scientific spectrum:

- Arts and Humanities (A&H)
- Social Sciences (SOC)
- Mathematics (MATH)
- Psychology (PSY)
- Immunology and Microbiology (IMM)
- Physics and Astronomy (PHY)

Indicators

For each university (all fields + the 6 selected subject fields) following indicators were calculated for the period 2003-2008 (6 years):

1) Output:
Number of publications (research articles, proceedings papers & review articles)

2) Percentage of research collaboration per type:
Different types of collaboration, i.e. "international", "international + national", "national", and "none" will be determined. Joint publications as a result of cooperation between institutional researchers and researchers from other countries are regarded as international publications. Those originating from collaboration between institutional researchers, researchers from other countries and researchers from the same country are assumed to be "international + national" publications. National publications are only authored by researchers from the same country but from different institutions. Finally, publications only co-authored by researchers from the same university can be regarded as publications without collaboration (domestic).

3) Impact
Normalized Impact scores indicate the scientific impact that institutions have on the scientific community. In order to obtain a fair impact measurement, its calculation removes any influences caused by institutional size and research profile. Thus normalization allows for research performance comparisons. Normalized Impact values show the ratio of the average institutional scientific impact to the world average impact of publications of the same time frame, document type and subject area. The values are expressed in percentages and show the relationship of the institution's average impact to the world average, which is 1, i.e. a score of 0.8 means that the institution is cited20% below world average and 1.3 means that the institution is cited 30% above world average (SCImago, 2009).

4) Brute Force

Following the definition used in the Leiden Ranking of Universities, introduced by the Centre for Science and Technology Studies (CWTS) of the Leiden University (Leiden Ranking, 2011), the Brute Force is a size-dependent impact indicator, obtained by the multiplication of the number of citable publications (articles, reviews and proceedings papers) with field-normalized average impact. It therefore balances productivity and impact. In this study an equivalent of the brute force has been calculated by multiplying the number of citable publications with SciMago Field-normalized average impact.

All searches in the source data were carried out between February and March 2011. The indicators obtained from the SIR were collected using the version available in that time frame.

Statistics

The following statistical tests were used to identify the differences between the collaboration types for the four regions according to their collaboration degree:

- the ANOVA (analysis of variance) test using either the region variable or subject area variable as a factor F, it shows similarities and differences.
- the Kruskal-Wallis H test (Kruskal and Wallis, 1952) detects if *n* data groups either belong or not belong to the same population. Since it is a non-parametric method, the Kruskal-Wallis test does not assume a normally distributed population, which makes it ideal for scientometric distributions (Ortega, 2011).
- finally, the Bonferroni Correction, post hoc test, used after the Kruskal-Wallis to address the problem of multiple comparisons.

Visualisation techniques

Multidimensional scaling (MDS), a set of statistical techniques, was used for exploring similarities or dissimilarities in data at university level.

The statistical analysis was based on SPSS Statistics 19.

Results

Different types of research collaboration and normalized citation impact

Figure 2 shows the percentage of the volume of each collaboration type and the normalized impact scores for all the universities considered in this analysis (40 universities belonging to 4 different geographic regions). "International + national" collaboration has the lowest volume but shows the highest normalized impact. On the other hand, publications "without collaboration" have the highest volume but the lowest normalized impact.

Thus, the highest degree of collaboration shows the biggest impact (collaboration and impact correlate positively).
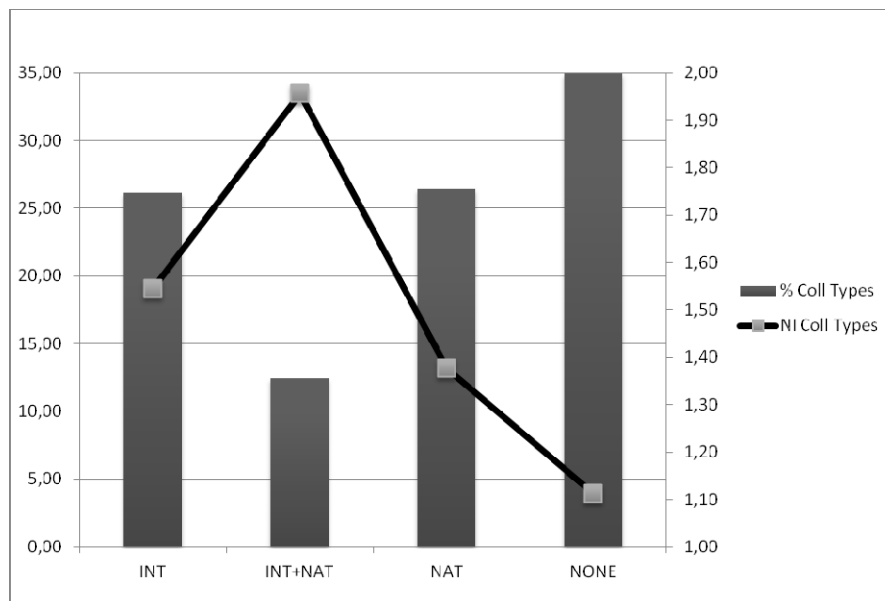
Fig. 2 Distribution of research collaboration types and normalized citation impact

Similarities and dissimilarities between universities: output and impact of research collaboration

The following figures represent two different MDS (Multidimensional Scalings), the first one depicts the output (volume) (Fig. 3) of each collaboration type, and the second one shows the normalized impact (Fig. 4). Universities are clustered corresponding to their degree of similarity based on the indicators used, volume and impact of each collaboration type. The clusters are predominantly composed of universities belonging to the same geographic region (distinguishable colours for each region), because they have more features in common at regional than at international level.

Interesting outliers can be identified regarding output volume in Fig. 3:

- Harvard University, Universidad Nacional de Mar de Plata and Universidad Federal de Pelotas (see upper right quadrant) all show an atypically (extremly) high volume of national collaboration
- Furthermore Harvard University has the smallest percentage of output without collaboration of (17%). All other North American universities in this analysis show values double as high.
- Korea Advanced Institute of Science and Technology (see lower right quadrant) has the highest volume of non-collaboration and the second lowest of "national + international" collaboration papers.
- Nanyang Technological University (see lower left quadrant) is similar to the Korean Advanced Institute of Science and Technology regarding the output of non-collaboration and "national + international" collaboration papers, however, the percentage of "international" collaboration is much higher.
- Universidad de Puerto Rico, Universidad Republica and City University of HongKong (see left part of Fig. 3) all have high percentages of both "international" and "non-collaboration" papers.

In contrast to output the universities show a higher similarity regarding normalized impact (see Fig. 4) with a concentrated cluster in the central part of the chart. However, clear differences (patterns) for each geographical region obviously exist. The left part represents universities of regions with lower impact values for all types of collaboration (Latin America, Asiatic Region), whereas the ones with the higher impact values (Western Europe and Northern America) can be found on the right side. The Universidad Federal de Pelotas and Erasmus University are outliers having a higher impact considering their international collaboration.

The exact values can be looked up for each university in Annex 2.

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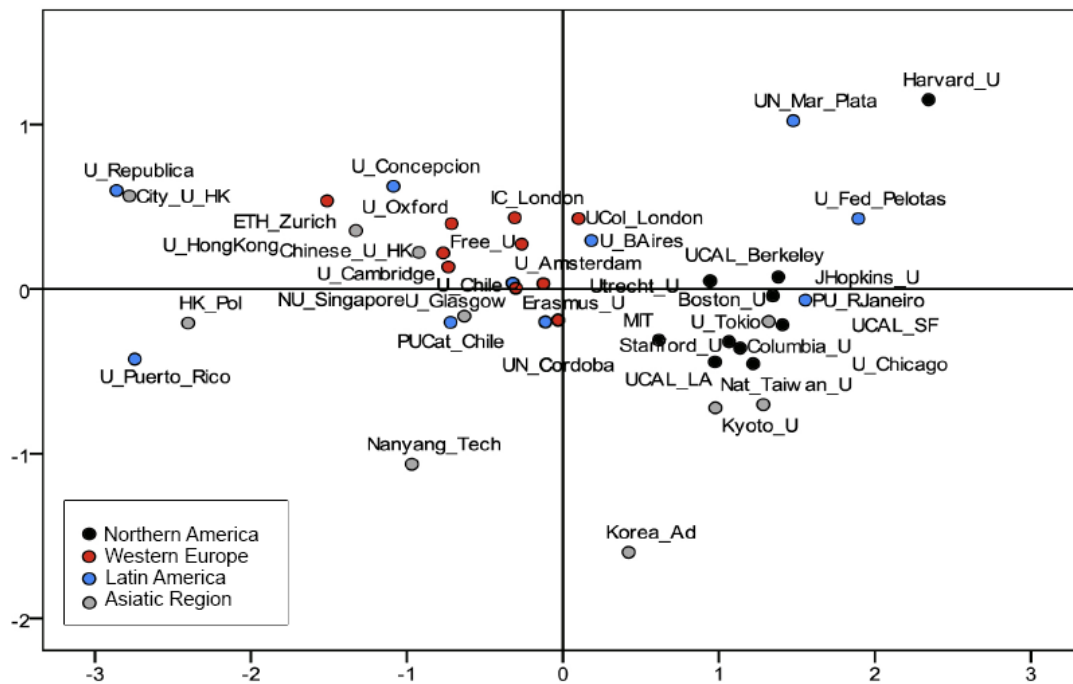
Fig. 3 Multidimensional Scaling (MDS) for output in collaboration types
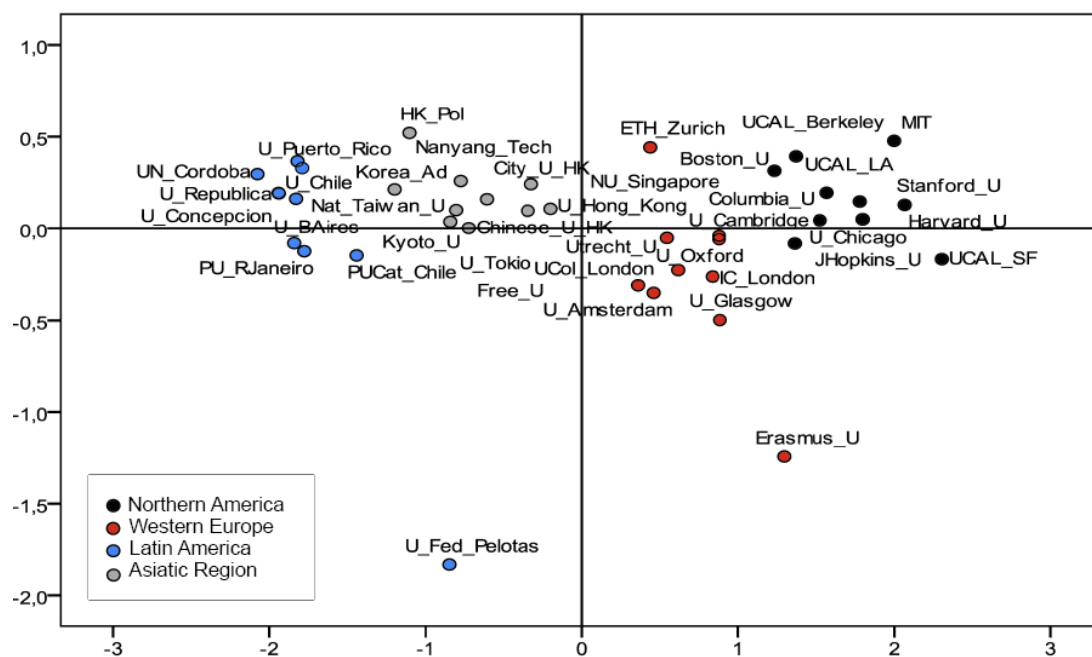
Fig. 4 Multidimensional Scaling (MDS) for Normalized citation by collaboration types

Do the collaboration and impact patterns differ from one region to another?

Fig. 5a and 5b shows the timeline of output and normalized impact for each collaboration type between 2003 and 2008 in all different regions.

General trends are readily identifiable for all regions and for each collaboration type regarding output (see Fig. 5a). All regions show an increase of "national + international" collaboration and a decrease of research output without collaboration. International collaboration also received a boost in three

regions, especially in the Asiatic one. This is not true for Latin America, where national collaboration grows constantly (in contrast to international collaboration) compared to the other regions.
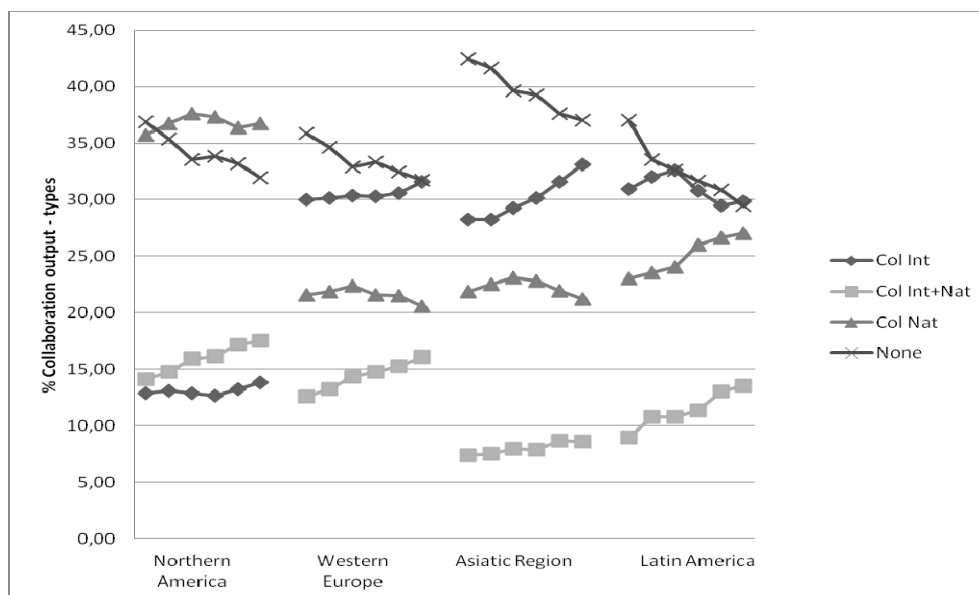
Fig. 5a Trend of output% per RC types by geographical regions
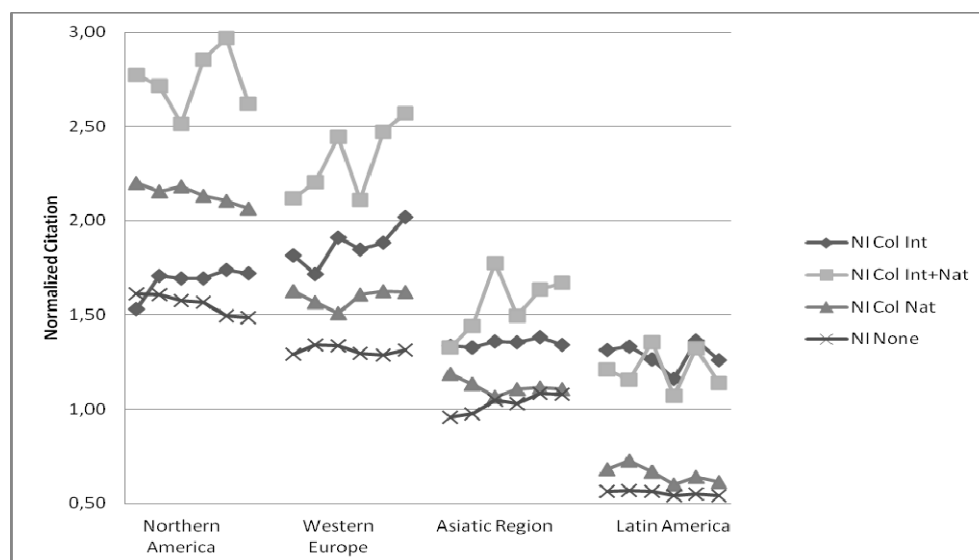
Fig. 5b Trend of Normalized Citation per RC types by geographical regions

Regarding normalized impact (see Fig. 5b) "national + international" collaboration is the most important collaboration type in all regions. Northern America is the only region where international collaboration is outweighed by national collaboration. Normalized impact is lowest for all collaboration types in Latin America. Whenever international collaboration is absent, Latin America remains below the world average.

Distribution of research collaboration types and normalized citation impact in 6 subject fields

A comparative analysis of six selected subject areas shows that the amount of publications without collaboration is extremely high in Arts & Humanities (71.76%), followed by Social Sciences (54.63%) and Psychology (37.16%). International collaboration reaches their maximum values in Mathematics

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and Physics with 35.33% and 33.49% respectively, whereas national collaboration is more common in Immunology (31.33%). For details refer to Fig. 6a.

Considering the normalized impact, publications with national + international collaboration score highly in the fields of Physics, Immunology, Mathematics, and even in the Social Sciences (see Figure 6b). International collaboration is most influential in Psychology, whereas the same is true for output of national collaboration in Arts & Humanities. Overall the documents originating from research without any collaboration have lower impact than those of all other collaboration types for all the areas analyzed.
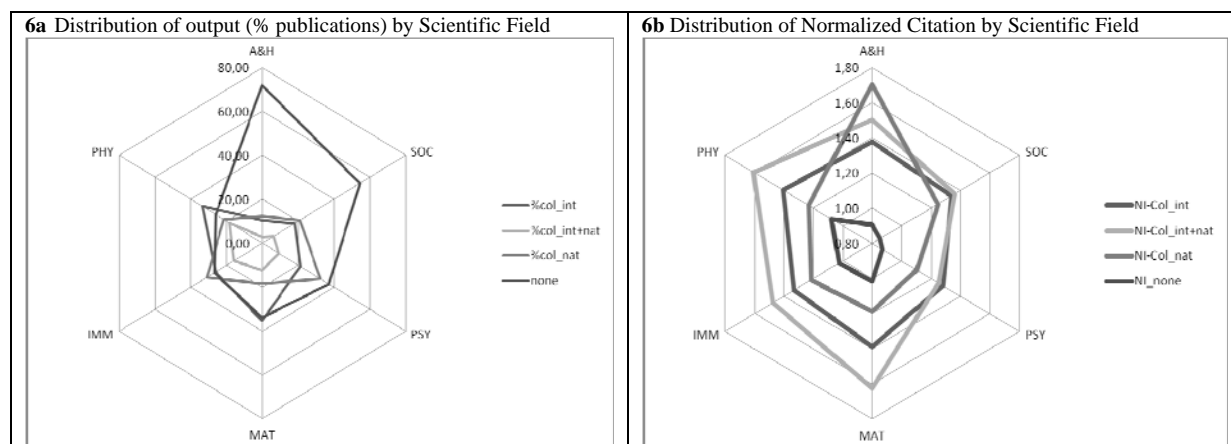
Fig. 6 Distribution of output and Normalized Citation per RC by Scientific Field

Brute Force
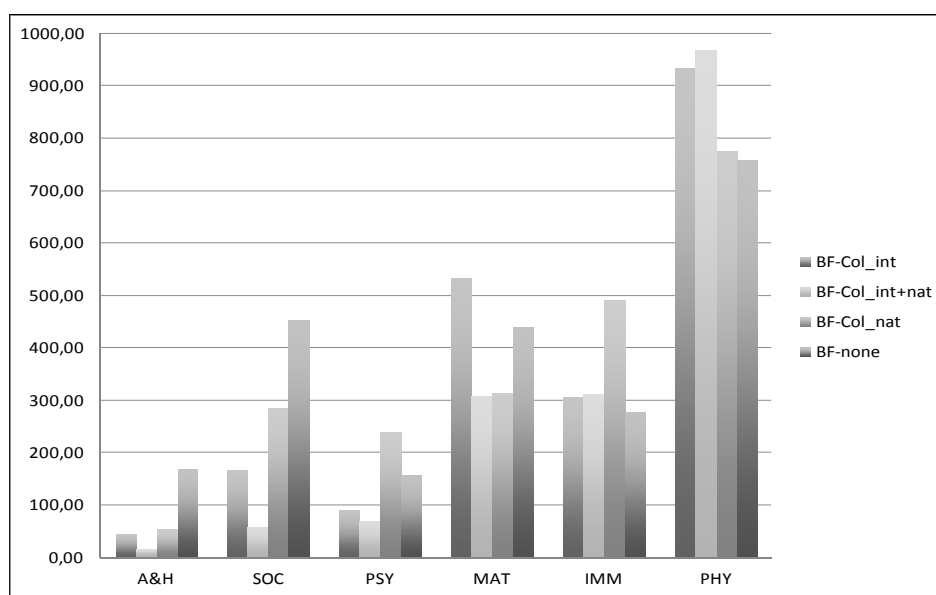
Fig. 7 Distribution of the Brute Force by Scientific Field according to the collaboration type

Figure 7 depicts the distribution of the annual mean Brute Force for the six considered areas. Each area obviously shows its very own characteristic pattern. The differences are most evident for Physics" and "Social Sciences"[2].
Therefore trends for both fields were further analyzed in more detail for each region.

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[2] *"Arts & Humanities" are even more different, however, the number of publications is too low in this field which makes further comparisons less relevant*

Fig. 8 Distribution of the Brute Force by region according to the collaboration type for two subject fields (clustered-stacked column chart)

In Physics (see Fig. 8a) non-collaborative publications account only for 20% of the Brute Force for all regions except for Latin America (approx. 15%). The biggest share of national collaboration comes from Northern America and the Asiatic Region. „International + national" collaboration represent the biggest contribution to the Brute Force in Northern America (approx. 35%) and in Western Europe (30%), whereas the values for the Asiatic Region and Latin America are much lower with 15% resp. 10%.

In "Social Sciences"(Fig. 8b) the situation is in stark contrast to Physics. Here the non-collaborative publications present the major share (almost 50%) of the Brute Force in all regions except Latin America (still 30%). In Social Sciences the percentage of "international + national" collaboration is generally low, and the contribution of international collaboration to the Brute Force becomes more important the lesser developed the region is.

Fig. 9 Trend of Brute Force per research fields by RC types

Figure 9 shows the time line of the Brute Force between 2003 and 2008 for each subject area according to the collaboration type. In Physics and Mathematics there is an increase in the first years followed by a decline in the last years for each collaboration type except for the international one. In

Social Sciences one can see a constant increase for all collaboration types, whereas in Arts & Humanities as well as in Psychology hardly any differences can be found.

Looking at the Brute Force percentages for each collaboration type in Physics as well as in Social Sciences these tend to show no major alterations along the analysed years (see Fig. 10).

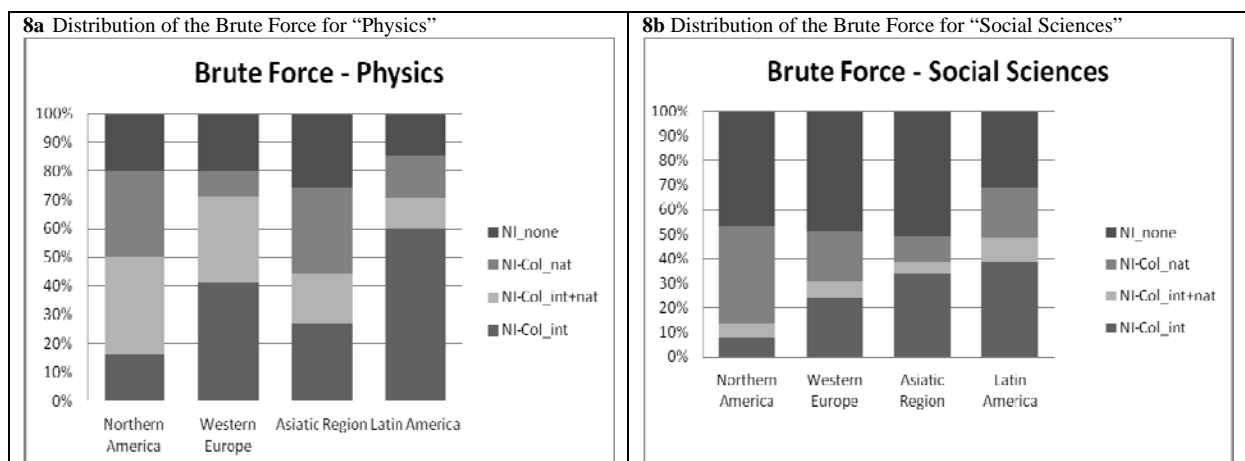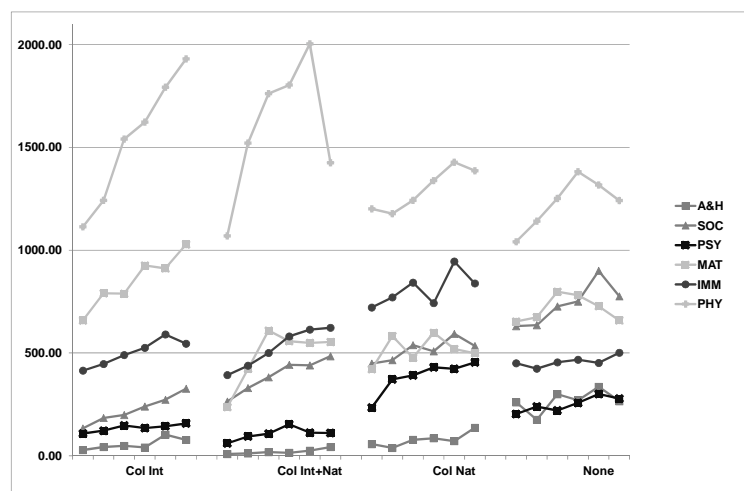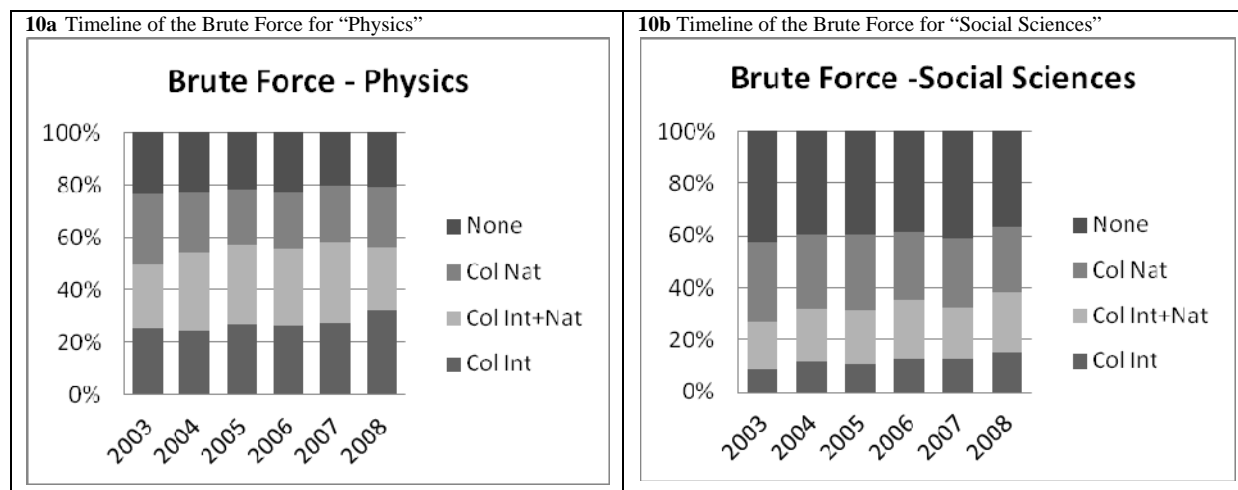| 10a Timeline of the Brute Force for "Physics"	10b Timeline of the Brute Force for "Social Sciences"

Fig. 10 Timeline of the Brute Force according to the collaboration type for two subject fields (clustered-stacked column chart)

Differences among regions and subject areas

Different patterns have already been recognized for each geographic region and subject category and were further explored by statistical tests analysing established pairs.

Considering first the geographical region as factor F, and applying the One Factor Anova test and of Kruskall-Walis H test, the p-value related to the value of F is less than $\alpha = 0.05$ (significance level for entire test series) for almost all the variables. Considerable differences occur between the geographical regions regarding output and normalized impact for all collaboration types. Only for documents originating from national collaboration (p = 0.010 in the Anova test and p = 0.013 in the Kruskall-Walis H test) and for documents without collaboration (p = 0.045 in Anova and p = 0.052 in Kruskall-Walis) significant regional similarities could be identified.

In order to identify considerable differences between regions and to find homogeneous groups, the Bonferroni correction was applied. Table 1 shows the normalized citation values for the different groups (clusters) that can be distinguished according to the four different collaboration types. Regarding international collaboration an overlap of the clusters was observed. Thus, the Asiatic Region (clusters A and B) has common characteristics with Latin America (via cluster A) and Northern America (via cluster B), whereas similarities occur between Northern America and Western Europe via cluster C. All the other collaboration types lack such an overlap with each region forming an own cluster.

Table 1 Regional Normalized Citation. Differences for each collaboration type (Bonferroni Correction Test)

a) Normalized Citation for International Collaboration				b) Normalized Citation for International + National Collaboration				
Region	**Mean**	**Cluster**		**Region**	**Mean**	**Cluster**		
Asiatic Region	1.351 A	B		Asiatic Region	1.557 A			
Latin America	1.283 A			Latin America	1.208	B		
Northern America	1.682	B	C	Northern America	2.741		C	
Western Europe	1.866		C	Western Europe	2.321			D

b) Normalized Citation for National Collaboration					
Region	**Mean**	**Cluster**			
Asiatic Region	1.119	A			
Latin America	0.655		B		
Northern America	2.140			C	
Western Europe	1.593				D

d) Normalized Citation for Without Collaboration					
Region	**Mean**	**Cluster**			
Asiatic Region	1.029	A			
Latin America	0.554		B		
Northern America	1.558			C	
Western Europe	1.312				D

Applying the same methodology, both statistical tests were run with the factor 'subject area'. All the variables related to the percentage of documents for each collaboration type show considerable differences in both Anova and Kruskall-Walis H. Quite different are the results for all the variables related to the normalized impact for each collaboration type, where the p-value related to the value F is much higher than $\alpha=0.05$ for all the variables. Only the Normalized Impact for the national collaboration is low (p=0.023).

Table 2 shows the mean output (percentages) of the subject areas for the different groups (clusters) that can be distinguished according to the four different collaboration types (p<0.05). Regarding international collaboration there is an overlap of the clusters A and C, i.e. a significant similarity between A&H and SOC was observed. Furthermore similarities occur between SOC, IMM and PSY (overlap of clusters B and C).

In general, A&H and SOC show common characteristics for all types of collaboration except "without" collaboration. Mathematics is related to SOC except whenever international collaboration occurs or to IMM and PSY for the other collaboration types.

PHYS, IMM and PSY show inconsistent clustering patterns.

Table 2 Differences between subject areas for each research collaboration type (Bonferroni Correction Test)

a) International Collaboration				
Subject Area	**Mean**	**Cluster**		
A&H	10.338	A		
SOC	18.133	A		C
MATH	35.326		B	
PHY	33.485		B	
IMM	26.188		B	C
PSY	21.230			C

b) International + National Collaboration						
Subject Area	**Mean**	**Cluster**				
A&H	2.925	A				
SOC	6.179	A				E
IMM	15.961		B	C		
MATH	12.276		B		D	
PSY	9.114				D	E
PHY	18.460			C		

c) National Collaboration				
Subject Area	**Mean**	**Cluster**		
A&H	12.262	A		
SOC	21.002	A		C
MATH	18.503	A		C
IMM	31.028		B	
PSY	32.416		B	
PHY	21.531			C

d) Without Collaboration						
Subject Area	**Mean**	**Cluster**				
A&H	71.775	A				
IMM	26.772		B	C		
MATH	33.845		B		D	
PHY	25.993			C		
PSY	37.156				D	
SOC	54.632					E

Conclusions

- There is a positive correlation between the degree of collaboration and the normalized impact (the more collaborators → the more impact; and vice versa). However, in contrast to output the normalized impact increase progression is non-linear and fluctuating.
- Differences occur regarding output volume and normalized impact at geographical region level for the leading universities.
  The Asiatic Region and Latin America have lower normalized impact than Northern America and Western Europe. However, considering the percentage of output, these regions have the biggest amount of international collaboration. Few regional outliers could be observed.
- Without surprise National collaboration in Northern America plays a different role in comparison to the other regions. North-American partners are obviously perceived as more

"interesting" than international ones, a phenomenon corroborated by the fact that national collaboration shows a much higher impact than pure international collaboration. However, large projects with national and international collaborators result in considerable impact gains.

- Harvard University, one of the most prestigious universities in the world, is outstanding with an extremely low percentage of publications without collaboration (<15%). This trend is not observed for the other top US universities, however, a continuously reduced percentage of the domestic (non-collaboration) academic output is a world trend.
- A steady increase of "international + national" collaboration is observed globally, however, less distinctive in Asia than in the other regions.
- Latin American papers originating from domestic production as well as from national collaboration have - in contrast to the ones from the Asiatic Region – a very low impact which remains considerably below world average values. Further research regarding the causes is needed, e.g. taking into account socio-economic factors (as pointed out by several authors) or database coverage bias.
- Brute Force analysis is a valuable complement to balance productivity and impact. It allows the detection of patterns at subject area level as well as at regional level.
- Looking at all universities in all regions studied in this analysis, A&H as well as SOC are the subject areas with the most "non-collaboration" output. Nevertheless the minority of collaboration papers result in normalized impact values comparable to the other analyzed subject areas. A&H national collaboration papers even produce the highest normalized impact in all fields.

In conclusion, relations between the degree of collaboration and impact are undeniable. Significant differences between the four analysed regions regarding output and impact patterns were observed. At the same time it was possible to determine a group of subject areas presenting similar patterns concerning their collaboration degree.

Nevertheless the authors are especially aware of two restrictions concerning this study. One is the bias concerning the database coverage, which most likely discriminates Latin America against the other analysed regions. Secondly, the USA represent a huge nation that is obviously difficult to compare to other countries at national level, particularly small countries in Europe. Here it would be more meaningful to contrast the USA with e.g. the whole EU (European Union).
Therefore further studies are planned to tackle these issues.

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Annex 1. Universities

REGIONS	UNIVERSITIES	Abbreviations
Northern America	Harvard University	Harvard U.
	Massachusetts Institute of Technology	MIT
	Stanford University	Stanford U
	University of California, San Francisco	UCAL SF
	Boston University	Boston U
	University of California, Berkeley	UCAL Berkeley
	University of Chicago	U Chicago
	Columbia University	Columbia U
	Johns Hopkins University	Jhopkins U
	University of California, Los Angeles	UCAL LA
Western Europe	Erasmus University	Erasmus U
	University of Oxford	U Oxford
	University of Cambridge	U Cambridge
	Swiss Federal Institute of Technology	ETH Zurich
	Imperial College London	IC London
	University College London	UCol London
	Unviersity of Glasgow	U Glasgow
	Utrecht University	Utrecht U
	Free University	Free U
	University of Amsterdam	U Amsterdam
Asiatic Region	The University of Hong Kong	U HongKong
	National University of Singapore	UN Singapore
	The Chinese University of Hong Kong	Chinese U HK
	City University of Hong Kong	City U HK
	Nanyang Technological University	Nanyang Tech
	University of Tokyo	U Tokyo
	Hong Kong Polytecnic University	HK Pol
	National Taiwan University	Nat Taiwan U
	Korea advanced institute of science and technology	Korea Ad
	Kyoto University	Kyoto U
Latin America	Pontificia Universidad Catolica de Chile	PUCat Chile
	Universidad de la Republica	U Republica
	Universidad de Buenos Aires	U Baires
	Universidade Federal de Pelotas	U Fed Pelotas
	Universidad de Puerto Rico	U Puerto Rico
	Universidad de Chile	U Chile
	Universidad de Concepcion	U Concepcion
	Universidad Nacional de Mar del Plata	UN Mar Plata
	Pontificia Universidade Catolica do Rio de Janeiro	PU Rjaneiro
	Universidad Nacional de Cordoba	UN Cordoba

Annex 2. General Results

Name Abbrev.	%_coll _int	NI_coll _int	%_coll _int_n at	NI_coll _int_n at	%_coll _nat	NI_coll _nat	%_none	NI_none
Harvard U.	10,08	1,81	23,00	2,63	49,71	2,25	17,22	1,68
MIT	17,21	1,78	15,23	2,53	29,49	2,44	38,08	1,87
Stanford U.	13,77	1,82	13,87	2,79	35,18	2,31	37,18	1,79
UCal. S. Francisco	11,40	1,70	13,82	3,28	39,06	2,21	35,05	1,47
Boston U.	12,97	1,50	14,58	2,55	39,06	2,04	33,39	1,35
UCal. Berkeley	15,57	1,66	17,95	2,38	32,95	2,13	33,53	1,66
U. Chicago	11,03	1,51	15,64	3,08	34,88	1,96	38,45	1,41
Columbia U.	12,65	1,66	14,57	2,79	35,14	2,00	37,64	1,44
J. Hopkins U.	12,57	1,72	16,75	2,71	38,59	1,93	32,10	1,37
UCal. LA	13,84	1,66	13,95	2,66	33,48	2,14	38,73	1,55
Erasmus U.	*26,42*	*2,55*	*10,57*	*2,70*	*25,21*	*1,62*	*37,80*	*1,25*
U. Oxford	*32,48*	*1,74*	*17,55*	*2,35*	*17,29*	*1,76*	*32,69*	*1,38*
U. Cambridge	*33,54*	*1,71*	*15,02*	*2,39*	*17,72*	*1,74*	*33,73*	*1,38*
ETH Zurich	*42,23*	*1,78*	*14,37*	*1,83*	*11,67*	*1,58*	*31,74*	*1,64*
Imp. Col. London	*29,68*	*1,75*	*17,05*	*2,52*	*22,23*	*1,54*	*30,88*	*1,34*
U. Col. London	*25,41*	*1,83*	*18,18*	*2,27*	*25,71*	*1,58*	*30,71*	*1,27*
U. Glasgow	*27,82*	*1,83*	*14,75*	*2,63*	*21,80*	*1,56*	*35,64*	*1,15*
Utrecht U.	*27,51*	*1,70*	*12,47*	*2,24*	*25,28*	*1,62*	*34,75*	*1,23*
Free U.	*30,53*	*1,88*	*12,05*	*2,08*	*25,46*	*1,49*	*31,97*	*1,23*
U. Amsterdam	*29,52*	*1,89*	*11,85*	*2,22*	*23,57*	*1,45*	*35,07*	*1,24*
U. Hong Kong	41,66	1,46	9,22	1,80	16,45	1,37	32,68	1,08
N. U. Singapore	31,06	1,41	11,47	1,66	19,35	1,29	38,13	1,22
Chinese U. Hong K	37,29	1,37	8,91	1,81	19,97	1,26	33,84	0,99
City U. Hong Kong	57,68	1,33	4,67	1,65	6,28	1,10	31,38	1,08
Nanyang Tech. U.	30,62	1,29	5,44	1,49	15,08	1,10	48,86	1,05
U. Tokio	13,09	1,42	12,51	1,61	39,26	1,09	35,15	0,88
Hong Kong Pol. U.	49,71	1,10	4,00	1,27	5,87	1,06	40,42	1,01
Nat. Taiwan U.	12,25	1,40	7,93	1,54	39,17	0,96	40,65	1,01
Korea Ad. Inst sci&	14,52	1,42	5,48	1,16	26,84	0,95	53,17	1,07
Kyoto U.	13,28	1,32	10,44	1,59	34,22	1,03	42,06	0,92
P. U. Cat. Chile	*31,22*	*1,36*	*12,16*	*1,38*	*17,89*	*0,71*	*38,72*	*0,60*
U. de la Republica	*58,48*	*1,06*	*5,85*	*1,13*	*5,50*	*0,59*	*30,17*	*0,56*
U. Buenos Aires	*25,45*	*1,29*	*14,97*	*1,15*	*28,31*	*0,58*	*31,27*	*0,53*
U. Fed. Pelotas	*13,54*	*2,62*	*10,75*	*1,75*	*48,28*	*0,57*	*27,44*	*0,62*
U. Puerto Rico	*51,57*	*1,14*	*2,87*	*1,00*	*1,98*	*0,93*	*43,59*	*0,49*
U. Chile	*33,98*	*1,11*	*12,12*	*1,14*	*19,67*	*0,57*	*34,23*	*0,70*
U. Concepcion	*40,21*	*1,07*	*12,52*	*1,10*	*18,19*	*0,63*	*29,09*	*0,53*
U. N. Mar del Plata	*17,01*	*0,97*	*19,03*	*1,13*	*42,87*	*0,72*	*20,75*	*0,60*
Pont. U. Rio Janeir	*13,56*	*1,25*	*10,38*	*1,28*	*43,50*	*0,66*	*32,57*	*0,39*
U. N. Cordoba	*24,56*	*0,97*	*13,43*	*1,03*	*24,34*	*0,60*	*37,67*	*0,53*