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The characteristics of highly cited researchers in Africa

Hugo Paris - 06/09/2017

STI2017 Conference – Paris

Acknowledgements:

CREST, University of Stellenbosch

Co-authors:

Charl Swart

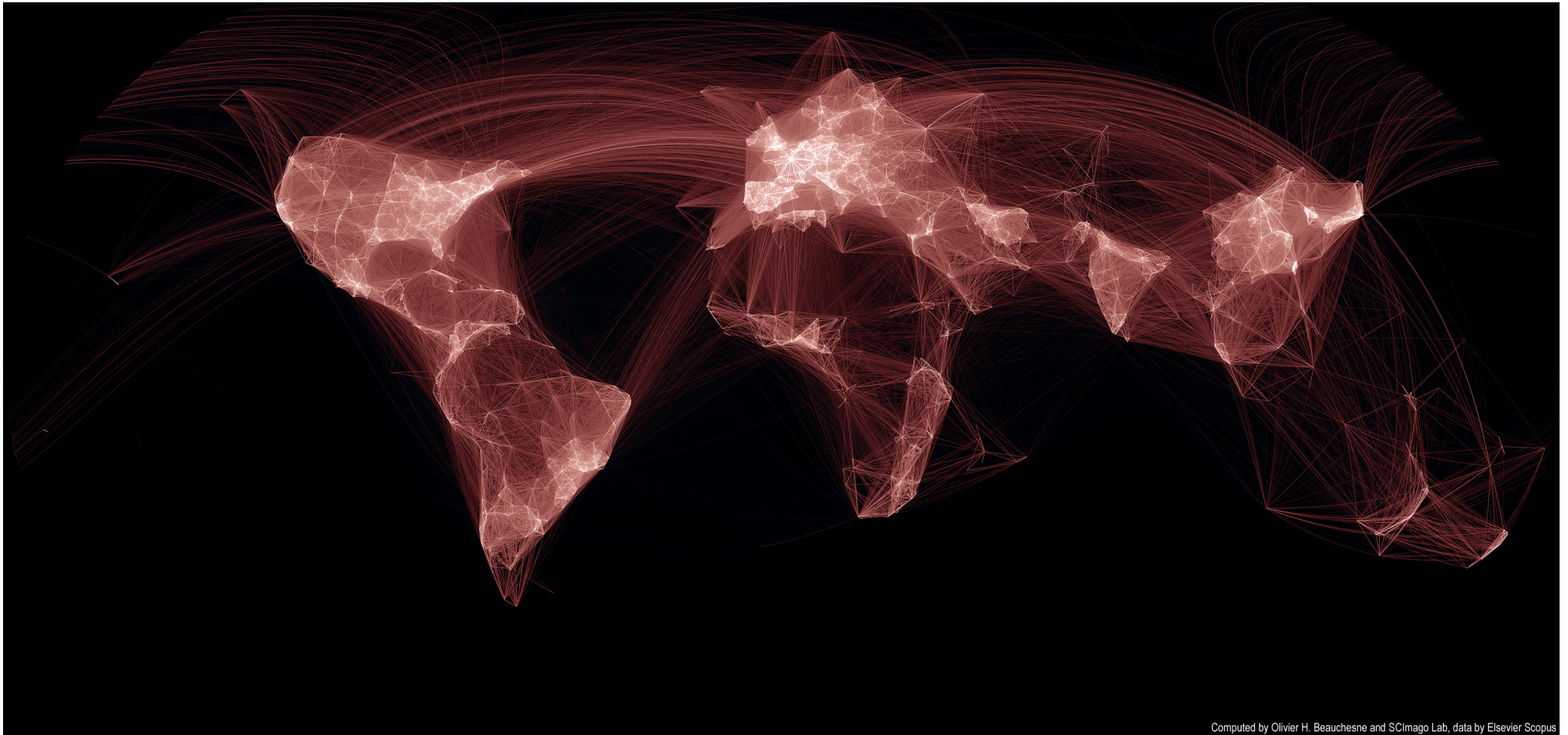
CREST, Univ. Stellenbosch

Jaco Blanckenberg

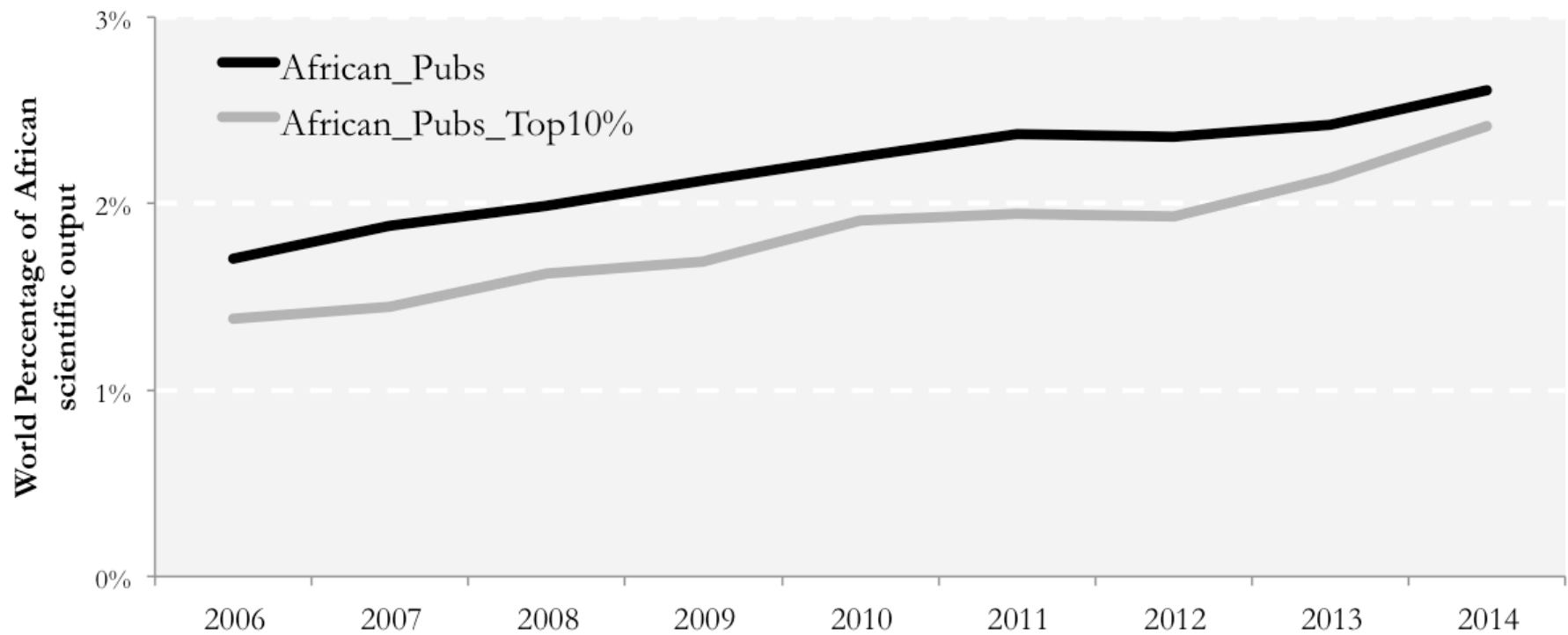
CREST, Univ. Stellenbosch



World scientific collaboration network 2008-2012



Motivation (I) – Trends in output & highly cited papers



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Motivation (II) – Why are HCRs important?

1. HCR are the people who are on the **cutting edge of their fields**. They are performing and publishing work that their peers recognize as vital to the advancement of their field. (Parker et al. 2010).
2. These scientists usually are **integrated in international networks** where new ideas and technologies are often being discussed. They can act as important conduits of frontier knowledge into the local academic research community (Barnard et al. 2012)
3. HCR are often seen as **key drivers of knowledge production for their countries** (Waldinger 2016). They usually obtain high amounts of international research funding and attract other good researchers, which can **reinforce the accumulation of scientific capabilities**.

What is a highly cited researcher?

- There are various ways to define a highly cited researcher (HCR):
 - Absolute number of citations (Garfield, 1977; 1981)
 - Thomson Reuters HCRs - top1% in 21ESI
 - Contributing to a set of very highly-cited publications in a specific field and year (e.g. Bornmann et al. 2017)



- **Highly cited publications** usually are associated with **opening a research field** or change the direction of a present field (Aksnes 2003; Aksnes and Rip 2009)



- In this study, we will consider researchers that **are authors of at least one of the top 5% and top 10%** most cited papers published each year in a certain field (WoS 250 fields), between 2005 and 2014.



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Examples (I)

Food-based approach introducing orange-fleshed sweet potatoes increased vitamin A intake and serum retinol concentrations in young children in rural Mozambique

By: Low, JW (Low, Jan W.); Arimond, M (Arimond, Mary); Osman, N (Osman, Nadia); Cunguara, B (Cunguara, Benedito); Zano, F (Zano, Filipe); Tschirley, D (Tschirley, David)

JOURNAL OF NUTRITION

Volume: 137 Issue: 5 Pages: 1320-1327

Published: MAY 2007

[View Journal Impact](#)

Abstract

Vitamin A deficiency is widespread and has severe consequences for young children in the developing world. Food-based approaches may be an appropriate and sustainable complement to supplementation programs. Orange-fleshed sweet potato (OFSP) is rich in beta-carotene and is well accepted by young children. In an extremely resource poor area in Mozambique, the effectiveness of introduction of OFSP was assessed in an integrated agriculture and nutrition intervention, which aimed to increase vitamin A intake and serum retinol concentrations in young children. The 2-y quasi-experimental intervention study followed households and children (n = 741; mean age 13 mo at baseline) through 2 agricultural cycles. In y 2, 90% of intervention households produced OFSP, and mean OFSP plot size in intervention areas increased from 33 to 359 m². Intervention children (n = 498) were more likely than control children (n = 243) to eat OFSP 3 or more d in the last wk (55% vs. 8%, P < 0.001) and their vitamin A intakes were much higher than those of control children (median 426 vs. 56 µg retinol activity equivalent, P < 0.001). Controlling for infection/inflammation and other confounders, mean serum retinol increased by 0.100 µmol/L (SEM 0.024; P < 0.001) in intervention children and did not increase significantly in control subjects. Integrated promotion of OFSP can complement other approaches and contribute to increases in vitamin A intake and serum retinol concentrations in young children in rural Mozambique and similar areas in Sub-Saharan Africa.

Keywords

KeyWords Plus: ACUTE-PHASE RESPONSE; BETA-CAROTENE; LEAFY VEGETABLES; DARK-GREEN; SCHOOL-CHILDREN; BLOOD SPOTS; DEFICIENCY; SUPPLEMENTATION; CONSUMPTION; YELLOW

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Citation Network

164 Times Cited

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(data from Web of Science Core Collection)

All Times Cited Counts

174 in All Databases

164 in Web of Science Core Collection

95 in BIOSIS Citation Index

5 in Chinese Science Citation Database

0 in Data Citation Index

0 in Russian Science Citation Index

4 in SciELO Citation Index

[Highly Cited Paper](#)

Usage Count

Last 180 Days: 1

Since 2013: 33

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Most Recent Citation

Girard, Amy Webb. Promotion of Orange-Fleshed Sweet Potato Increased Vitamin A Intakes and Reduced the Odds of Low Retinol-

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Combination of bibliometric and survey data

- **Bibliometric data**
 - WoS (2005-2014) – Articles & reviews
 - Top 5% and Top 10% more cited articles
 - Authors that have an African affiliation (whole/full counting method)
- **Survey data**
 - Run by CREST (Univ Stellenbosch) between May 2016 and January 2017
 - Sent to all researchers with an African affiliation that were authors of publications in WoS during the last ten years (2005-2015)
 - The questionnaire response rate was acceptable (~10%), with 7513 answers.
- **Matching**
 - Using algorithms to identify **email addresses**, names and affiliations in both datasets
 - **3271 observations** compose our final sample. **260 are top10%; 145 are top5%.**



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Factors that affect the probability of producing a highly cited paper

- **Experience***
 - Productivity = Pubs/academic age (Abramo et al. 2014; Larivière and Costas 2016; Sandström and van den Besselaar 2016)
 - Academic age (Kuhn, 1962 & Simonton, 1999 VS Merton, 1968)
- **Demographic characteristics**
 - Region of highest qualification - knowledge recombination & mover's advantage (Fleming 2001; Franzoni et al. 2014; Uzzi et al. 2013)
 - Gender (ambiguous...)
- **Challenges faced in their career (1 to 3)**

Scientific institutions in many African countries suffer from specific challenges such as poor conditions and opportunities for research personnel, lack of funding and political instability (Mouton 2008)

 - Mentoring and support
 - Training opportunities
 - Mobility opportunities



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Factors that affect the probability of producing a highly cited paper

- **Collaboration effects** (Glänzel et al. 1995; Katz and Martin 1997; Narin et al. 1991)

Collaboration intensity (1 to 5) with researchers at:

- their own institution
- other institutions in their own country
- institutions in other African countries
- institutions outside of Africa*

- **Working habits**

- Number of hours worked (Parker et al. 2010)
- Percentage of time spent in: a) research; b) supervising postgraduate students; c) raising funds for research; d) undergraduate and postgraduate teaching

- **Funding resources**

- Being the primary recipient/grant holder of some research funding (Gök et al. 2016; Wang and Shapira 2015)
- % International Funding (Gök et al. 2016)



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Conceptual Framework for Econometric Analysis

Multivariate probit regression model using cross-section data (errors clustered at the subject area level):

$$\Pr(Y_a = 1 \mid X_{1a}, X_{2a}, \dots, X_{ka}) = \Phi(\beta_0 + \beta_1 X_{1a} + \beta_2 X_{2a} + \dots + \beta_k X_{ka})$$

- **Dependent variable** – dummy variable (y) that is 1 for an researcher with an African affiliation, which is a (co-)author in a highly cited paper (top 10% or top5% in each of the 250 WoS Categories), and 0 for a non-highly cited researcher with an African affiliation.
- **Independent variables** – Academic age*, productivity, higher qualification non-Africa, hours worked (8-80), time spent in different activities (4*), level of collaboration (4*), challenges faced in the career (4*), funding holder (3y), % of international funding (3y).
- **Robustness checks to see differences between:**
 - Younger vs older researchers (\leq or > 10) - Friesenhahn and Beaudry (2014)
 - Subject areas (5 OECD)
 - Africa regions (ZA; non-A. resident; Northern A.; E&C&W)

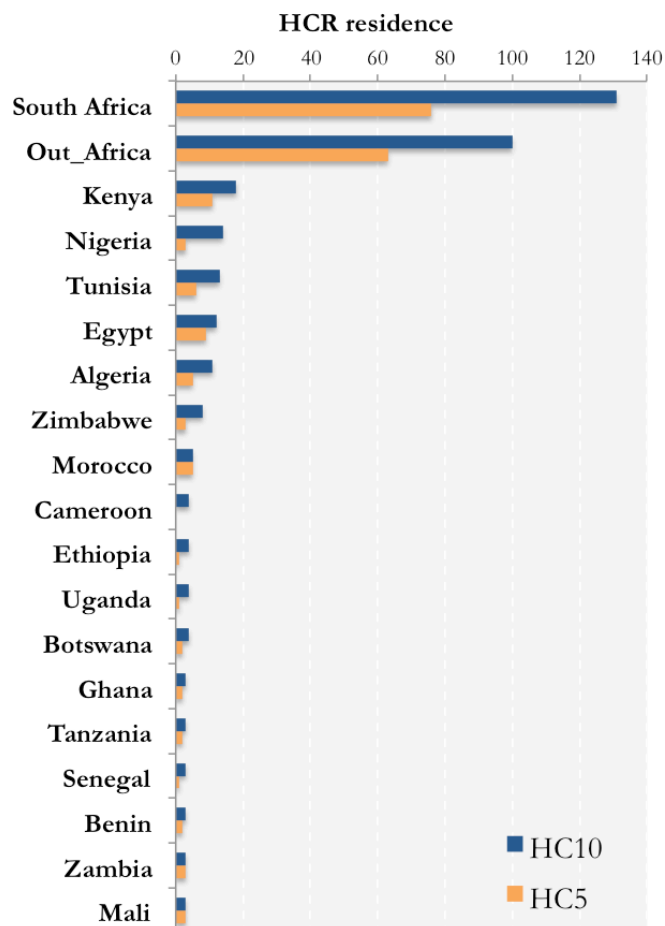
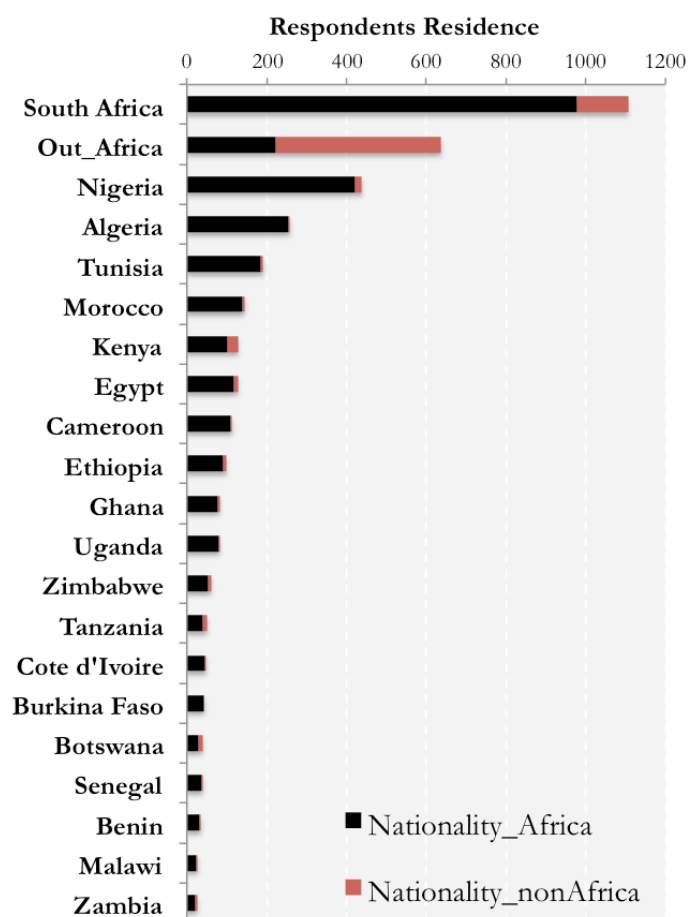


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Descriptive Analysis (II) – Geographical representation



- South African predominance
- Relevance of foreign researchers
- Egypt is underrepresented

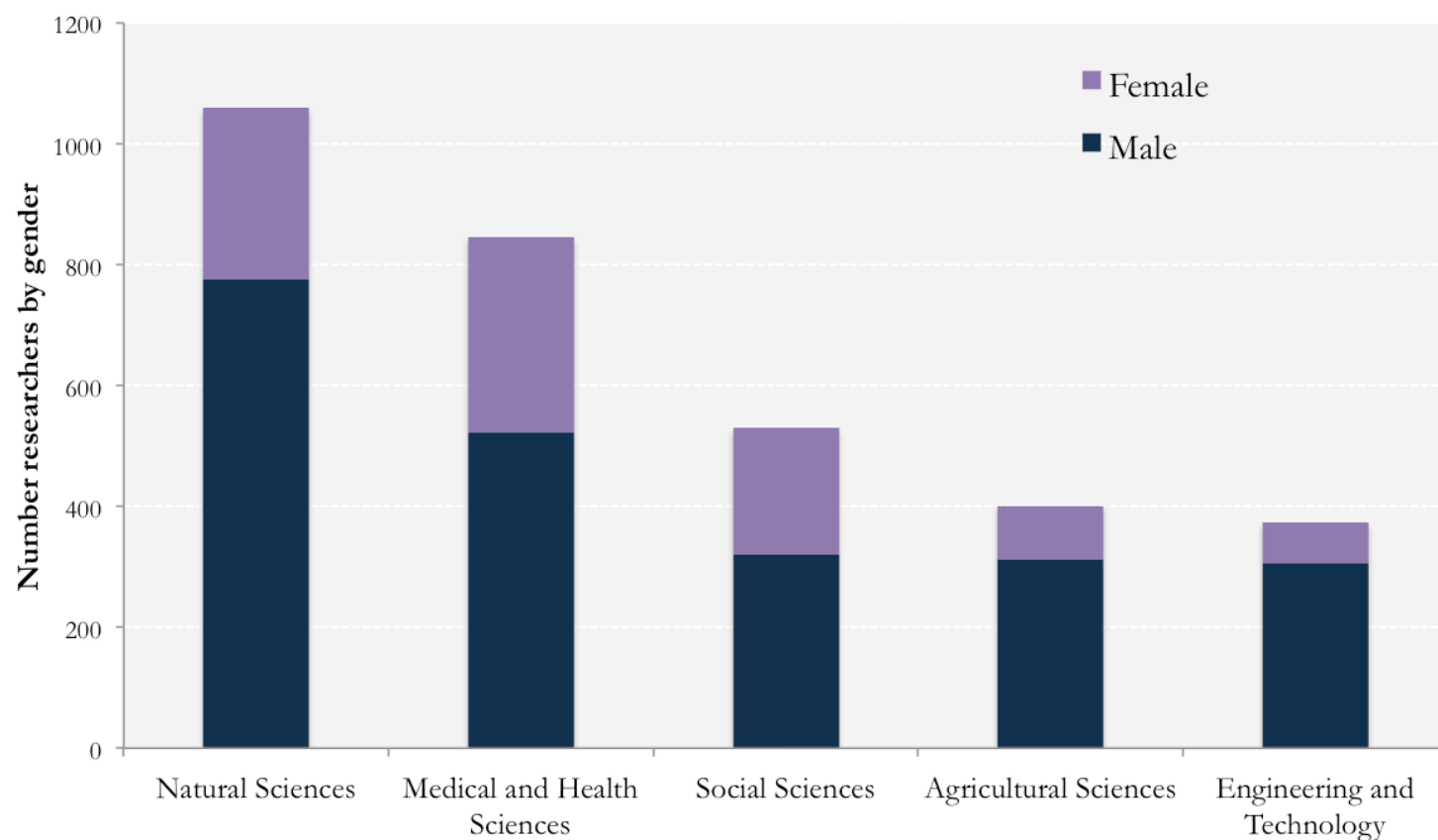


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Descriptive Analysis (III) – Gender and subject area



- Humanities were excluded
- Gender differences by field were expected
- There are highly cited authors in every category

Descriptive Analysis (I) – Summary statistics

Variables	Obs	Mean	Std. Dev.	Min	Max
HC10_Dummy_20102014	3271	0.08	0.27	0	1
HC10_Dummy_20052009	3271	0.04	0.19	0	1
HC5_Dummy_20102014	3271	0.04	0.21	0	1
HC5_Dummy_20052009	3271	0.02	0.14	0	1
academic_age_wos	3271	10.40	8.16	0	46
academic_age2_wos	3271	174.66	283.98	0	2116
productivity_wos	3271	1.14	1.48	0.06	18.24
Qualif_nonAfrica	3271	0.34	0.47	0	1
Gender	3208	1.30	0.46	0	1
Challeng_Lackmentorship	3271	1.96	0.71	1	3
Challeng_Lackmobilityopport	3271	1.94	0.74	1	3
Challeng_trainingopport	3271	1.98	0.75	1	3
COL_owninst	3237	3.96	1.13	1	5
COL_outsideafrica	3237	3.17	1.36	1	5
COL_otherinst_owncountry	3237	3.20	1.16	1	5
COL_othercountry_insideafrica	3238	2.22	1.25	1	5
WOR1_hoursweek	3271	37.22	16.35	8	80
Timespent_UnderPostTeaching	3260	22.06	20.05	0	100
Timespent_Research	3260	29.43	20.92	0	100
Timespent_Supervising	3260	16.01	12.66	0	100
Timespent_Raisingfunds	3260	4.75	6.53	0	60
Funding_dummy	3271	0.41	0.49	0	1
Funding_ShareInternational	3271	25.94	39.01	0	100

- Evolution of HC10 is high
- Average productivity is 1.14 paper per year. Max = 18
- **34% did the PhD abroad**
- 30% female
- **Collaboration is higher with institutions outside Africa than with institutions from other African countries**
- 41% were primary holders of funding in the last 3 years
- The share of international funding is 26% on average



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Econometric Results (I) – top10% vs top5%

Independent Variables	Dependent Variables						Independent Variables	Dependent Variables					
	Dummy_Top10%_Probit_est			Dummy_Top5%_Probit_est				Dummy_Top10%_Probit_est			Dummy_Top5%_Probit_est		
	(1)	(2)	(3)	(1)	(2)	(3)		(1)	(2)	(3)	(1)	(2)	(3)
Academic_age_wos	0.0133*** (0.00334)	0.0290 (0.0205)	0.0203 (0.0185)	0.0132*** (0.00255)	0.0230 (0.0211)	0.0208 (0.0215)	COL_owninst	-0.0205 (0.0322)	-0.0185 (0.0359)		-0.0111 (0.0439)	-0.0129 (0.0479)	
Academic_age2_wos		-0.000486 (0.000485)	-0.000351 (0.000434)		-0.000306 (0.000550)	-0.000345 (0.000544)	COL_outsideafrica	0.0634** (0.0274)	0.0603** (0.0299)		0.0954*** (0.0334)	0.0921*** (0.0356)	
Productivity_wos	0.237*** (0.0316)	0.210*** (0.0342)	0.185*** (0.0284)	0.173*** (0.0224)	0.154*** (0.0275)	0.141*** (0.0213)	COL_o.inst_owncountry	0.00742 (0.0481)	0.0112 (0.0439)		-0.0405 (0.0331)	-0.0384 (0.0315)	
Qualif_nonAfrica	0.261*** (0.0756)	0.199* (0.106)	0.165 (0.102)	0.391*** (0.0463)	0.333*** (0.0433)	0.330*** (0.0309)	COL_o.country_in.africa	-0.0177 (0.0284)	-0.0220 (0.0268)		-0.0268 (0.0281)	-0.0257 (0.0268)	
Gender	0.0112 (0.0395)	-0.0339 (0.0596)	-0.0353 (0.0648)	0.111 (0.103)	0.0928 (0.123)	0.111 (0.121)	WOR1_hoursweek	0.000422 (0.00222)	-4.05e-05 (0.00219)		-0.00313 (0.00372)	-0.00438 (0.00361)	
Challeng_Lackmentorship	-0.0620 (0.0389)	-0.0571 (0.0371)	-0.0666 (0.0410)	-0.0227 (0.0755)	-0.00870 (0.0765)	-0.0158 (0.0829)	Timespent_UnderPostTeaching	-0.00353* (0.00211)	-0.00258 (0.00274)		-0.00496** (0.00220)	-0.00391 (0.00258)	
Challeng_Lackmobilityopport	-0.0737 (0.0653)	-0.0581 (0.0865)	-0.0487 (0.0822)	-0.0370 (0.0805)	-0.0246 (0.112)	-0.0256 (0.108)	Timespent_Research	0.00398 (0.00247)	0.00414 (0.00276)		0.00457 (0.00295)	0.00533 (0.00355)	
Challeng_trainingopport	-0.0865*** (0.0335)	-0.0720** (0.0292)	-0.0795*** (0.0268)	-0.158*** (0.0393)	-0.149*** (0.0542)	-0.165*** (0.0551)	Timespent_Supervising	0.00363 (0.00653)	0.00284 (0.00659)		0.00406 (0.00648)	0.00353 (0.00607)	
							Timespent_Raisingfunds	0.0128* (0.00733)	0.0136 (0.00834)		0.00624 (0.00543)	0.00831 (0.00586)	
							FundingRecipient_dummy	0.124 (0.139)	0.0946 (0.121)		0.125 (0.145)	0.102 (0.129)	
							Funding_ShareInternational	-0.000512 (0.000496)	-0.000288 (0.000586)		-0.000325 (0.00108)	-0.000377 (0.000968)	
							HC10_Dummy_20052009		1.009*** (0.123)				
							HC5_Dummy_20052009					1.102*** (0.140)	
							Constant	-1.653*** (0.186)	-2.055*** (0.173)	-1.976*** (0.190)	-2.072*** (0.326)	-2.316*** (0.386)	-2.274*** (0.353)
							Observations	3,208	3,178	3,178	3,208	3,178	3,178
							R-squared	0.1642	0.1882	0.2268	0.1509	0.1785	0.2106

- Productivity is consistently positive and significant
- Acad. age is significant when not controlling age^2
- Qualif. Non-Africa also positive and significant
- Challenges are negative as expected but only significant for training opportunities
- Collaboration outside Africa is positive and significant
- Time spent on teaching negative and significant when non

Note: *** p<0.01, ** p<0.05, * p<0.1. Std. error adjusted for 5 clusters (areas).

- Productivity is consistently positive and significant
- Acad. age is significant when not controlling age²
- Qualif. Non-Africa also positive and significant
- Challenges are negative as expected but only significant for training opportunities
- Collaboration outside Africa is positive and significant
- Time spent on teaching negative and significant when non controlling for lag dependent variable
- Lag dependent variable always positive and significant



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Econometric Results (II) – top10% by age

Ind. Variables	Dependent Variable – Dummy_Top10%_Probit_est			
	acad_age_wos ≤10	acad_age_wos >10	acad_age_wos ≤10	acad_age_wos >10
Academic_age_wos ←	0.0612*** (0.00513)	0.00973*** (0.00177)	0.0544*** (0.00519)	0.00768*** (0.00198)
Productivity_wos	0.228*** (0.0462)	0.206*** (0.0419)	0.213*** (0.0450)	0.176*** (0.0331)
Qualif_nonAfrica ←	0.208*** (0.0777)	0.211 (0.157)	0.221*** (0.0808)	0.142 (0.160)
Challeng_trainingoport ←	-0.138*** (0.0516)	-0.0964*** (0.0367)	-0.137** (0.0543)	-0.103** (0.0481)
COL_outsideafrica ←	0.0413 (0.0311)	0.108*** (0.0258)	0.0328 (0.0335)	0.104*** (0.0252)
Timespent_UnderPostTeaching ←	-0.00706** (0.00350)	-0.00291 (0.00412)	-0.00634* (0.00380)	-0.00180 (0.00447)
Timespent_Raisingfunds	0.00831 (0.00851)	0.0157 (0.0147)	0.0106 (0.00935)	0.0146 (0.0153)
HC10_Dummy_20052009			1.232*** (0.367)	0.984*** (0.137)
Constant	-1.978*** -0.195		-2.121*** (0.206)	
Observations	3,228		3,228	
R-squared	0.1949		0.2289	

- Productivity is consistently positive and significant
- The coefficient of academic age is higher for younger researchers (decreasing marginal returns).
- PhD outside Africa more important for younger researchers
- Lack of training opportunities also more relevant for younger researchers
- Time spent on teaching also seems to penalize more younger researchers
- Collaboration outside Africa more important for older researchers

Note: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1. Std. error adjusted for 5 clusters (areas).



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Econometric Results (III) – Subject area differences

Ind. Variables	Dependent Variable – Dummy_Top10%_Probit_est				
	Natural Sciences	Agricultural Sciences	Engineering and Technology	Medical and Health Sciences	Social Sciences
Academic_age_wos	0.0080 (0.0064)	-0.0079 (0.011)	-0.014 (0.011)	0.0051 (0.0087)	0.036*** (0.011)
Productivity_wos	0.27*** (0.044)	0.30*** (0.075)	0.092* (0.049)	0.20*** (0.047)	0.16** (0.076)
Qualif_nonAfrica	0.37*** (0.13)	0.25 (0.22)	0.27 (0.23)	-0.13 (0.15)	-0.078 (0.19)
Challeng_trainingopport	-0.10 (0.074)	-0.29** (0.13)	-0.017 (0.12)	-0.22** (0.097)	-0.0069 (0.11)
COL_outsideafrica	0.070 (0.046)	0.16** (0.073)	0.060 (0.079)	0.077 (0.060)	0.074 (0.057)
Timespent_UnderPostTeaching	-0.0086** (0.0035)	-0.0052 (0.0082)	0.0019 (0.0048)	-0.0023 (0.0052)	-0.011** (0.0056)
Timespent_Raisingfunds	-0.0023 (0.010)	-0.0014 (0.011)	0.021 (0.019)	0.038*** (0.0084)	0.0024 (0.013)
HC10_Dummy_20052009	0.86*** (0.23)	1.27*** (0.45)	1.74*** (0.39)	0.82*** (0.25)	0.99*** (0.35)
Constant			-2.027*** (0.171)		
Observations	3,228				
R-squared	0.2531				

- Academic age is particularly important in Social sciences
- Productivity is consistently positive and significant
- PhD outside Africa only for Natural Sciences
- Lack of training opportunities affect more negatively on Agricultural Sciences and Medical and Health Sciences
- Collaboration outside Africa is more important on Agricultural Sciences
- Time spent on teaching, negatively on Natural and Social Sciences
- Time spent raising funds is particularly important on Medical and Health Sci.

Note: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1. Std. error adjusted for 5 clusters (areas).



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Econometric Results (IV) – Regional differences

Ind. Variables	Dependent Variable - Dummy_Top10%_Probit_est			
	non-Africa	South Africa	Northern Africa	E&W Africa
Academic_age_wos	0.00018	0.0076*	0.00015	0.0073
Productivity_wos	-0.0087	-0.0039	-0.013	-0.0056
Qualif_nonAfrica	0.22***	0.17***	0.21***	0.23***
Challeng_trainingopport	-0.062	-0.045	-0.073	-0.024
COL_outsideafrica	0.29	0.38*	0.40**	-0.015
Timespent_UnderPostTeaching	-0.19	-0.22	-0.19	-0.13
Timespent_Raisingfunds	-0.32*	-0.15*	-0.12	-0.09
HC10_Dummy_20052009	-0.16	-0.079	-0.099	-0.065
Constant	0.16***	0.091***	0.091***	0.04
Observations	-0.023	-0.023	-0.023	-0.037
R-squared	0.006	-0.0047	-0.0078**	-0.0032
	-0.0037	-0.0052	-0.0032	-0.0034
	0.0043	0.016	0.011	0.014
	-0.0042	-0.013	-0.012	-0.0096
	0.57***	1.07***	1.59***	0.51***
	-0.14	-0.093	-0.18	-0.11
			-1.96***	
			(0.13)	
			3,729	
			0.2479	

- Productivity is consistently positive and significant
- PhD outside Africa more important for Northern Africa
- Collaboration outside Africa, very important for all regions except for Eastern and Western Africa (for them only productivity and previous performance matter)
- More time spent on teaching negative and significant for South Africa
- Lag dependent variable always important



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Preliminary Conclusions

- The growing number of papers and highly cited papers with an African author has been strongly backed up by South African scientific production and African based outside of Africa.
- **Higher productivity** is associated with higher probability of producing HC papers*
- Researchers that reported that during their career they had a **lack of training opportunities** have a lower probability of having a highly cited publication.
- For **younger researchers** (academic age ≤ 10) having done their **PhD outside Africa** and spending relatively **less time teaching** is associated with a higher probability of producing highly cited research.
- For **older researchers** that is not so important. For them, **collaborating more often with researchers outside of Africa** is much more relevant.



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Implications for policy

- 1) Cumulative properties of scientific production.
- 2) Well targeted personal support at the beginning of a career can play a decisive role in fostering professional growth and success of young scholars.
 - Training opportunities are important, but also
 - Spending less time teaching and having the opportunity to go abroad to do the PhD (!)
- 3) The characteristics of highly cited researchers may not be the same in different subject areas and different regions.

Limitations

- Binary approach – What is the frontier?
- We assume that a co-author of a highly cited paper is necessarily a important author in the paper (design, methodology and writing)
- Our variables related to collaboration patterns, funding received, challenges faced and time spent on different activities are assumed to be constant during the career of all researchers in this survey
- There may be other factors that are also relevant for our model that are not included:
 - Inherent (childhood) ability or genius of a researcher (Simonton 1999)
 - Professional marginality from the discipline they changed (Kuhn 1962)
 - The “lucky” element in science or serendipity (Roberts 1989)



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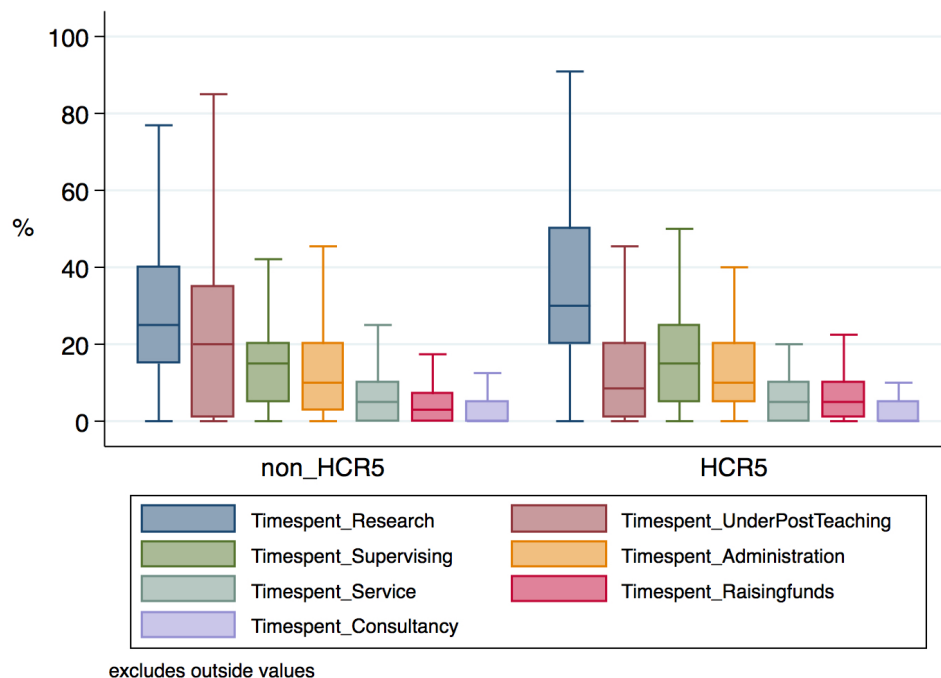
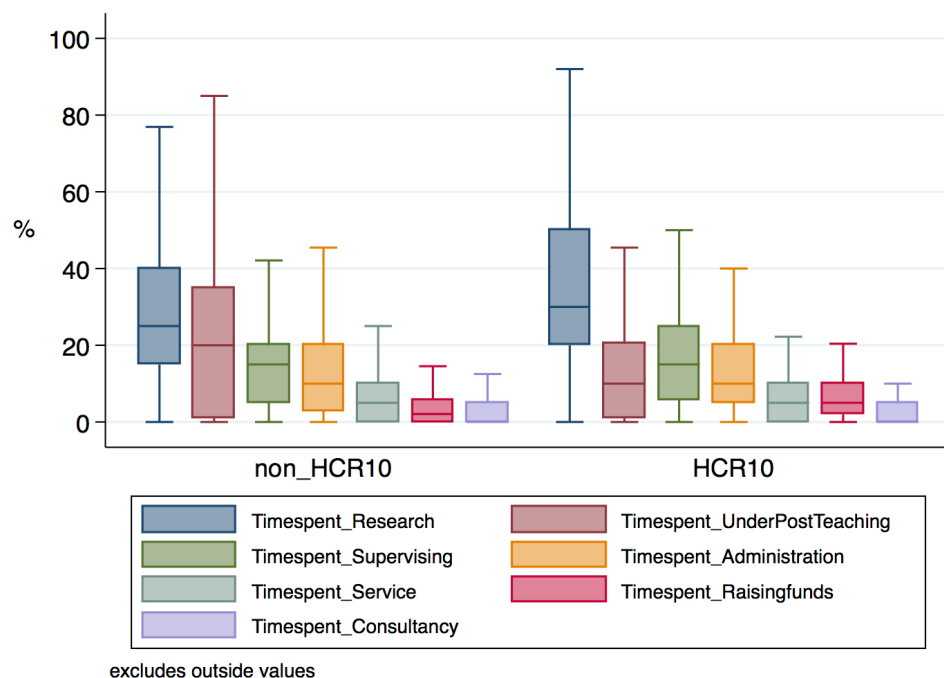
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Thank you!

Descriptive Analysis (II) – Hours worked per HCR (top1 & top10)



- HCR10 & HCR5 ~ 42 hours a week; non-HCR10 = 37 hours a week
- Number of hours spent on teaching seems to be the only substantial difference
- Raising funds and research to a certain extent...

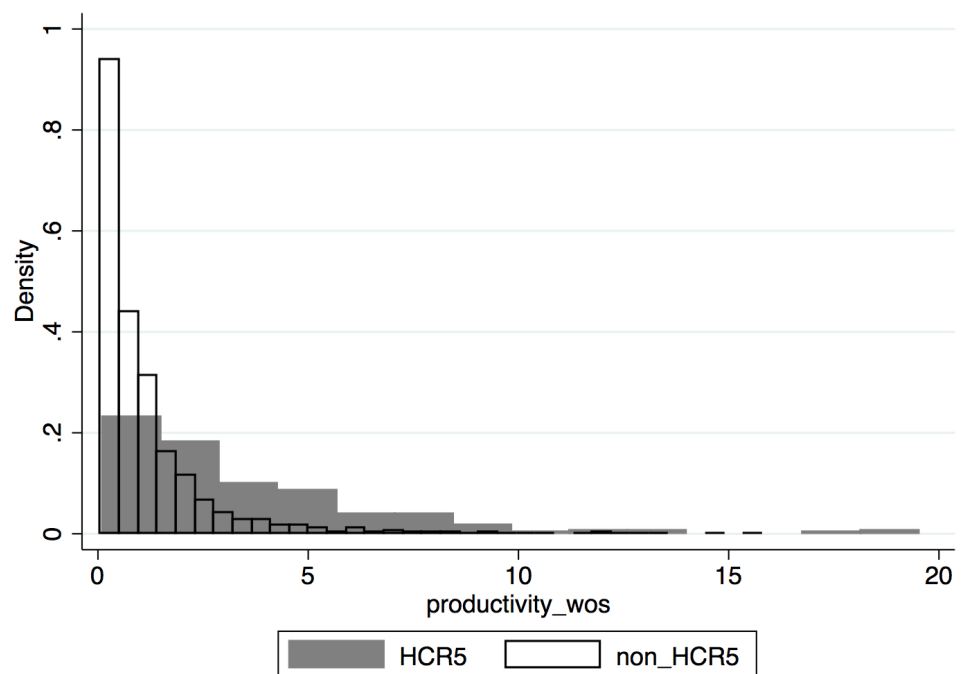
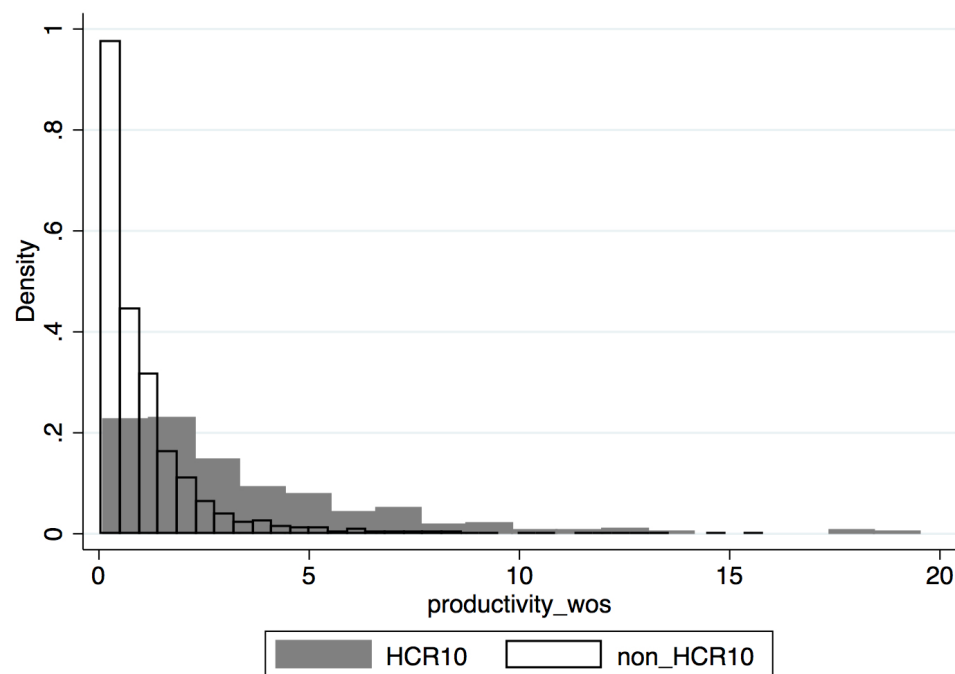


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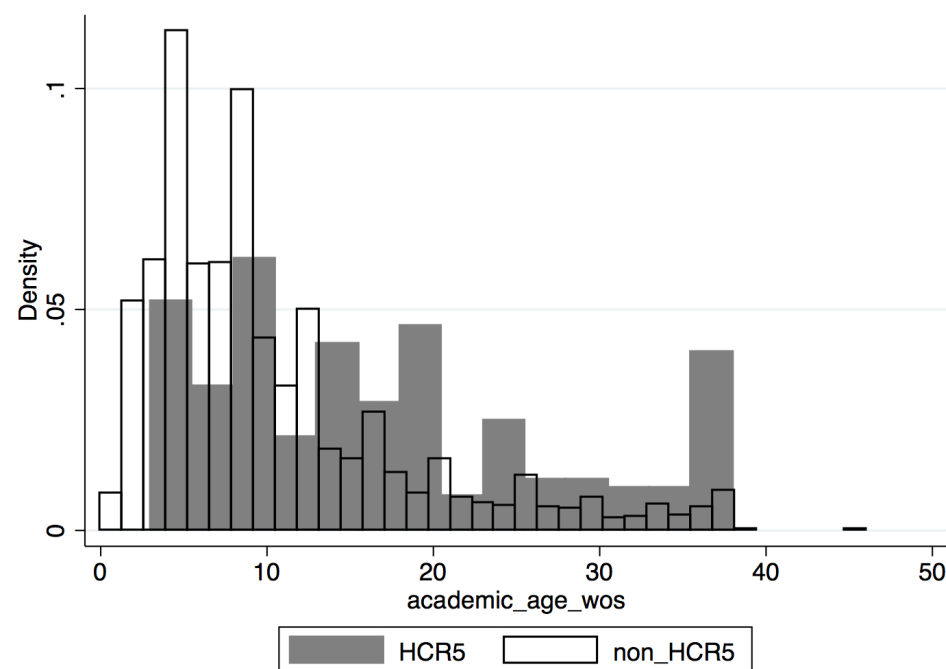
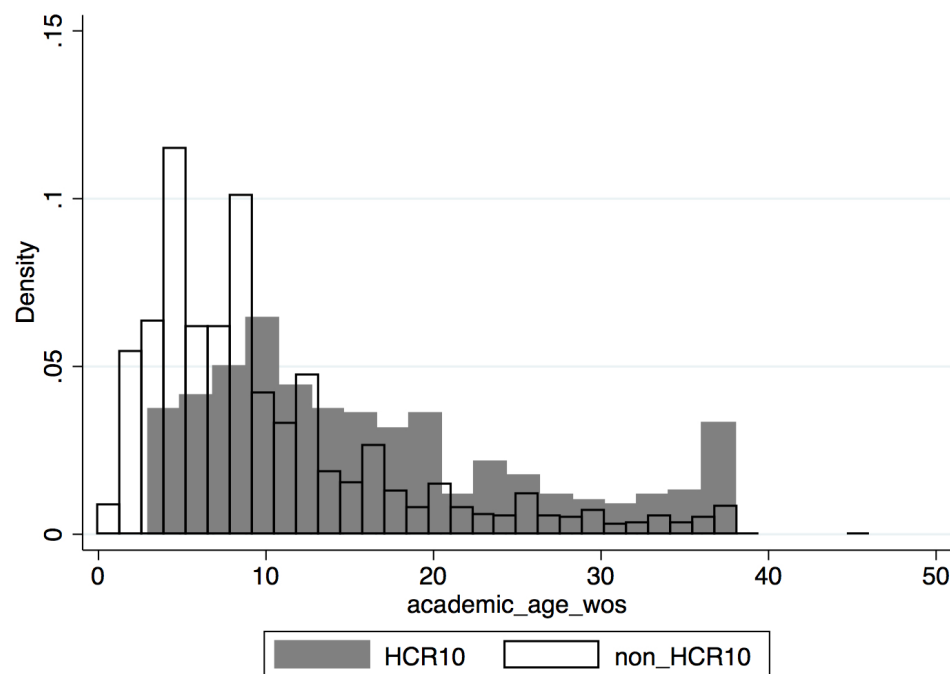
Descriptive Analysis (III) – Academic age per HCR (top10 & top5)



- HCR produce approximately three times more papers per academic year than non-HCR (3.3 vs. 1.1).



Descriptive Analysis (IV) – Productivity per HCR (top1 & top10)



- As regards academic age the difference is not that large. On average the academic age of HCR is 1.6 higher than non-HCR (16 vs. 10).

