

Chapter 22

Which factors influence international research collaboration in Africa?

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Abstract

It is commonly accepted that international research collaboration improves scientists' abilities and performance. In this chapter we investigate the question: what are the characteristics of African researchers who collaborate more often with international partners? Data are taken from Web of Science and a survey that collected detailed information about the individual characteristics of 2954 African researchers in 42 African countries. We use descriptive statistics and an econometric model to discern the characteristics that are associated with higher levels of collaboration with researchers outside Africa. Overall our results suggest that, on average, researchers who did their doctoral studies outside of Africa, had the opportunity to move abroad (over the past three years) and received a higher share of international funding (over the past three years), are more likely to collaborate more frequently with researchers outside of Africa. In our conclusions we discuss that beyond increasing the availability of mobility scholarships and the amount of research funding for African scientists, policy makers and international organizations should also think in incentives to keep long-term research interactions and try to avoid unequal partnerships.

Keywords

Research collaboration, African science, scientific capabilities, research policy

Introduction

The Sustainable Development Goals (SDG) encompass the interlinkages of the three dimensions of economic growth, social development and environmental sustainability. In Africa, critical to all these dimensions is the development of skills and capabilities that allow human development and structural transformation of the 54 economies to productive structures based on industrial development and modern services (Gaye et al. 2015).

In order to achieve SDG 4 (Quality education) and 9 (Industry, innovation and infrastructure) it was stated that it is specifically important to enhance the scientific and technological capabilities of low and middle-income countries. One of the known mechanisms to improve those capabilities is by increasing the intensity of research collaboration with other international partners. The benefits of international collaboration are widely acknowledged and include access to expertise, complementary know-how and new techniques, generation of learning opportunities, improving networking activities, better access to funding and equipment, national and international recognition (AOSTI 2014; Arvanitis and Gaillard 2014; Beaver 2001; Bozeman and Corley 2004; Katz and Martin 1997; Wagner et al. 2001). These benefits are also recognized in SDG 17 (Partnerships for the goals) where an important target is to “Enhance North-South, South-South and triangular regional and international cooperation on and access to science, technology and innovation and enhance knowledge sharing on mutually agreed terms (...)”. Yet, despite a long history of cross-border cooperation between researchers worldwide, there are few empirical studies on the main drivers of international research collaboration in lower income regions.

This raises the questions of why some researchers collaborate more often with international partners than others; and secondly, what form should collaborative research take to overcome the pitfalls associated with the North-South divide? We will address these issues by studying the characteristics of African researchers who collaborate both frequently and infrequently with non-African researchers. This will be achieved by relying on survey data, bibliometric data and employing ordered probit regression analysis.

Most of the previous research that analyzes the intensity of international research collaboration of specific authors relies on the use of co-authorship of scientific publications from different countries. However, co-authorship is seen as a partial indicator of collaboration since scientific collaboration may happen without resulting in a co-authored paper (Katz and Martin 1997; Laudel 2002). In our work, we will use a subjective measure of collaboration that was captured by a large survey sent to all African researchers who (co-) authored an article in WoS (Web of

Science) and Scopus between 2005 and 2015. The questionnaire included items that asked respondents how often (1-5 Likert scale) they collaborate, either in joint research or through joint publications, with researchers at “their own institution”, “other institutions in their own country”, “institutions in other African countries” and “institutions outside of Africa”. The last item of this question will be employed as the dependent variable to assess the collaboration intensity outside of Africa of individual researchers.

In our study, we are particularly interested in investigating whether doing the highest qualification (PhD) outside Africa, recent mobility and receiving a higher share of research funding from outside Africa allows African researchers to collaborate more frequently outside Africa. The richness of the data allows us to control for a large number of characteristics including academic age, scientific productivity (number of publications per academic age), challenges faced (lack of mobility opportunities, lack of research funding and lack of mentoring), gender, region and subject area.

Background

The total research output from researchers in Africa is a small proportion of global science. It is highly skewed across nations and disciplinary areas, and most countries rely heavily of international funding and international collaboration to sustain their research systems (Confraria & Godinho, 2015; AOSTI, 2014). Therefore the notion of “African science” may be misleading, as previously suggested by Tijssen (2007).

The importance of international collaboration and the legacy of colonial ties are recognized as playing a pivotal role in Africa’s scientific output. Bibliometric studies usually find little scientific co-authorship between African countries with preference being given to collaboration with higher income nations (Guns and Wang 2017; Mègnigbèto 2013; Narváez-Berthelemot et al. 2002; Onyancha and Maluleka 2011). When African countries do collaborate with one another, frequently those collaborations have been initiated by a non-African country (Boshoff 2009; Toivanen and Ponomariov 2011) or mediated through cooperative health and agricultural programs (Adams et al. 2013). Also it has been suggested that African researchers are rarely leading authors in international publications and that their role is often still primarily limited to collecting data and linking up with domestic policy debates (Boshoff 2009; Carbonnier and Kontinen 2014).

Yet, from a policy perspective, international collaborations are seen as one of the most efficient means to build research capacity and to create learning opportunities for African researchers (AOSTI 2014). With the limited resources that most African universities have, building

international collaborations can allow individual researchers to access infrastructures and scientific networks, which they would not have access to when working in isolation. Therefore, governments and international organizations allocate substantial resources to promote international research.

Several policies can be endorsed to improve links between national researchers and researchers in other countries. Some examples include expanding the number of scholarships that allow PhD students and researchers to go abroad to interact with peers; increasing the amount of research funding provided by governments and international organizations to research projects in African countries, and attracting foreign scholars to work and do research in African institutions. For example, target 4b of the SDG committed the 193 signatories to the agreement to “substantially expand globally the number of scholarships available to developing countries”. In this chapter, the question of which set of policies could contribute to improving international research collaboration is one of our driving questions. By investigating the characteristics of researchers who collaborate more often outside of Africa, we aim to contribute to the nuanced policy discussion surrounding this issue.

The main characteristics of internationally collaborating researchers

One consistent finding in studies focusing on the factors that affect international collaboration is mobility. The networking power of doing a PhD, post-doc, visiting or going to conferences abroad are particularly important in initiating long-lasting scientific collaborations (Arvanitis and Gaillard 2014; Jonkers and Tijssen 2008; Marmolejo-Leyva et al. 2015; Scellato et al. 2015). In our study we will measure mobility in three dimensions: 1) Doing the highest qualification in a non-African country; 2) having studied or worked abroad in the past three years; and 3) perceiving that lack of mobility opportunities impacted negatively their career to a large extent.

While mobility is a main concern, other important dimension is the availability and source of research funding. Existing research indicates that international collaboration increases in the long-run in consequence of the use of funding schemes that encourage cross-country collaboration (Defazio et al. 2009) and foreign funding increases the number of South-North collaborations (Zdravkovic et al. 2016). Our survey included three questions about funding: 1) Being or not a primary recipient of research funding in the last three years; 2) the share of international funding received in the last three years (primary recipient or not); and 3) perceiving that lack of research funding impacted negatively their career to a large extent. We will use these three variables to examine how research funding can impact higher levels of international collaboration.

Finally individual characteristics of the researcher may also play a role. Across all areas of research, older researchers tend to have more collaborators (Wang et al. 2017), more productive scientists tend to cooperate more (Lee and Bozeman 2005); and males tend to collaborate more often with researchers abroad (Abramo et al. 2013). At the same time, scholars agree that mentoring can be associated with a wide range of positive outcomes such as productive research careers, motivational benefits, better preparation in making career decisions, and increased network opportunities (Allen et al. 2004; Evans et al. 2008). Therefore in our analysis we will also include as independent variables academic age (2017 – year of first publication in WoS), scientific productivity (number of publications in WoS/academic age), gender and perceiving that lack of mentoring was a challenge that they faced during their career.

Due to the structure of our data, we cannot claim a causal relationship between these features and collaboration intensity with researchers outside Africa. We do not have longitudinal data and thus cannot observe changing patterns over time. Nevertheless, we take a first step in analysing what characteristics are associated with researchers who collaborate internationally.

Data and Methodology

This chapter combines survey with bibliometric data. Survey data were collected via a self-administered, web-based, structured questionnaire sent to all researchers with an African affiliation that were authors of publications in Web of Science or Scopus between 2005 and 2015¹. It was adapted from the questionnaire used for the Global State of Young Scientists precursor study (GLOSYS) (Friesenhahn and Beaudry 2014) and for GLOSYS in ASEAN (Geffers et al. 2017). The questionnaire is divided into 10 sections: educational background; employment; working conditions; research output; funding; career challenges; international mobility; collaboration; mentoring; and demographic characteristics and contains a total of 36 items. It was initially developed in English and then translated into French in order to increase the probability of receiving responses from countries that have French as a primary language. The survey was administered between May 2016 and February 2017. The questionnaire response rate was an acceptable (10%), with 7513 answers.

Some of the researchers who completed the questionnaire do not have a fixed residence in Africa or may not have a nationality from an African country. Any researcher that published one article with an African affiliation between 2005-2015 may have completed the form. In our analysis we exclude authors that reported that their residence and nationality is not in/from an African country. We made this decision because the conditions and settings of researchers with

an African affiliation who are not based in an African country, or were not born in an African country, may be very different from our population of interest.

Our analysis also excluded researchers who reported that they belong to Humanities related fields due to the limitations of bibliometric indicators in this area (Hicks et al. 2015; Marx and Bornmann 2014). Finally, researchers who didn't answer all our questions of interest were also removed from the final sample. After applying these restrictions, 2954 researchers compose our final sample. Despite the high number of responses, the survey observations, based on an uncontrolled sample, cannot be considered as representative of the targeted populationⁱⁱ. However, the characteristics of the sample show a fair representation among regions, subject areas and gender. Furthermore, several robustness checks were done in order to assess the validity of our model and results.

The source of bibliometric data is WoS. All articles and reviews from researchers with an African affiliation, published between 1980 and 2016, were extracted. After collecting our sample of articles with an author with an African affiliation we extracted the email addresses, names and affiliations of all African authors involved and we matched that info with the info of the authors that completed our survey.

Approach

Our analytical section is composed of two segments. In the first section, we use descriptive statistics to examine trends in African scientific production and to study our sample of researchers. In the second part we will use an ordered probit model, an econometric tool that allow us to discern the characteristics that are associated with higher levels of collaboration with researchers outside Africa.

The ordered probit model involves a qualitative dependent variable for which the categories have a natural order that reflects the magnitude of some underlying continuous variable (Greene 2012). In our case the dependent variable is expressed in terms of five categories (1 – Never, 2 – Rarely, 3 – Sometimes, 4 – Often, 5 – Very often) which could be viewed as resulting from a continuous variable called “collaboration intensity”. All the other characteristics are treated as independent variables that can potentially affect collaboration intensity. The starting point is an index model, with single latent variable:

$$y^* = x' \beta + \varepsilon$$

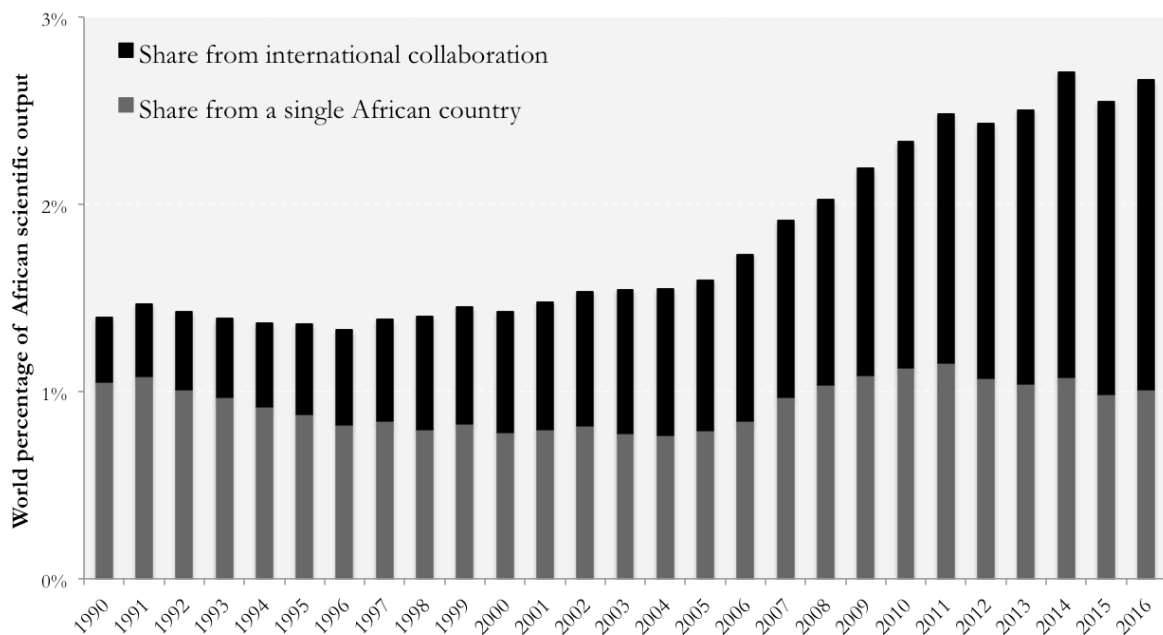
where x are a set of characteristics of each researcher, that in our case are: (1) location of highest qualification (African or non-African); (2) having studied or worked abroad during the last three

years; (3) being a primary recipient of research funding over the past three years; (4) share of international funding received over the past three years; (5) perceiving that lack of mentorship, mobility, and funding was a factor that affected negatively their career to a large extent. To avoid omitted variable bias, controls will be added for individual characteristics such as academic age, scientific productivity, gender, subject area and African region. In the model ε is disturbance and y^* is unobserved.

Results

The scientific output in Africa has increased considerably during the last decade. In Fig. 1, we can observe that the total world share of articles and reviews in Africa increased from 1.4% in 1990 to 2.7% in 2016. However, as shown in Fig. 1, since 2006 this increase has been mainly driven by international collaborations (publications that have at least one foreign author).

Figure 1. Trends in the share of international scientific collaboration in Africa



Source: Own elaboration and WoS.

This finding demonstrates the importance of international collaboration for African scientific output and motivates our research question to a certain extent.

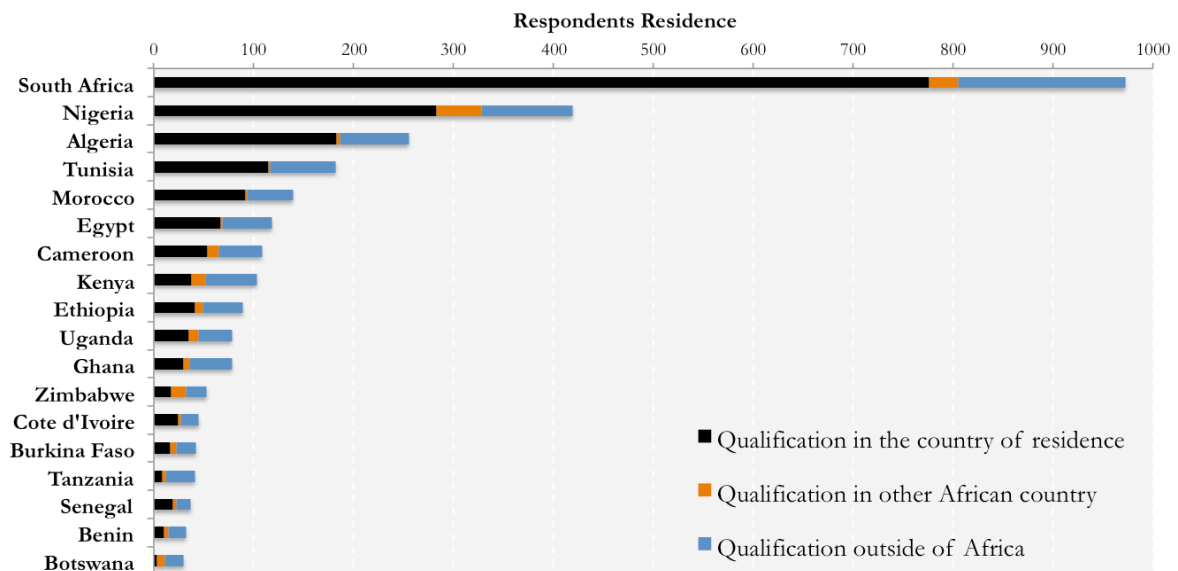
Our survey respondents comprise a fraction of the total number of African researchers. Around 81% have a PhD and 92% reside in the country of their nationalityⁱⁱⁱ. In Fig. 2 we can observe that, geographically, 32.4% (973) of the African researchers in our sample are based in South Africa. The other three countries with the most respondents are Nigeria (14%), Algeria (8.7%)

and Tunisia (6.2%). At the same time, South Africa is the country with the smallest percentage of researchers who did their highest qualification outside of Africa (17.2%). On the other end, Tanzania (71.4%), Botswana (63.3%), Ghana (53.8%) and Benin (50%) are the countries with highest level of researchers with a non-African highest qualification. These findings surely raises the need for infrastructural development in those countries highly dependent on foreign institutions to train their researchers.

The share of researchers with a qualification in an African country different from their country of residence is relatively small. Northern African countries have very few of those researchers and the country with most researchers who had their highest qualification in a different African country is Nigeria (45).

These results mirror the predominance of the South African research system within Africa. Besides having much more researchers than the other African countries, they produce a bigger share from their own system.

Figure 2. Number of researchers resident in an African country (by location of highest qualification).



Source: Own elaboration.

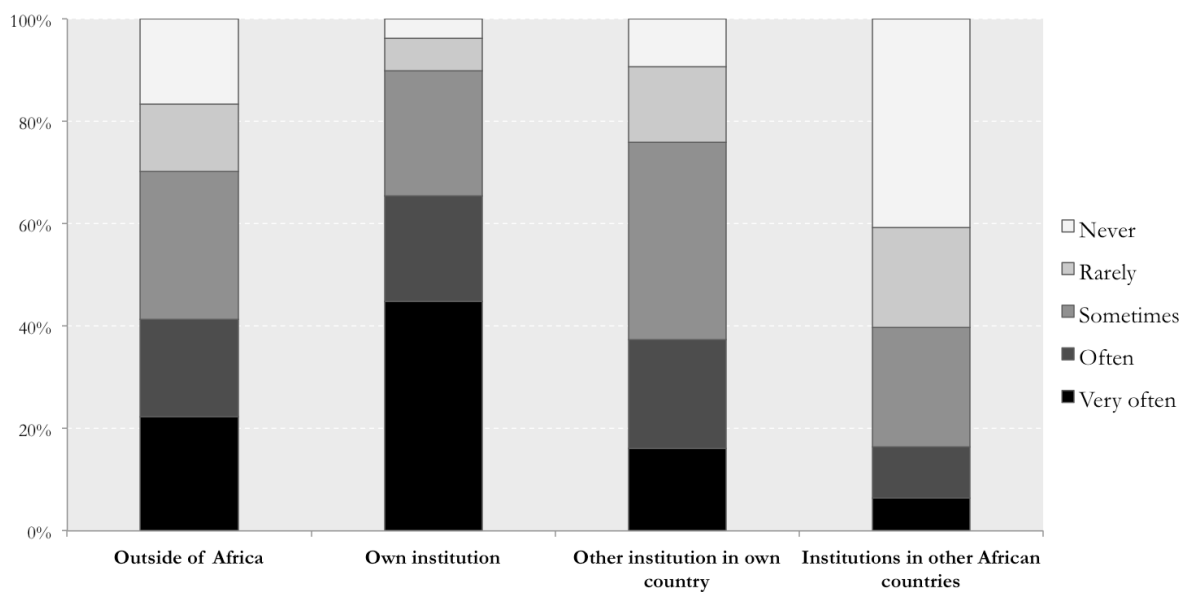
Note: We only included in this graph African countries that have at least 30 responses.

We have reasons to believe that researchers from Egypt are underrepresented in this sample. According to UNESCO (2015), Egypt accounts for more than 20% of the total number of publications with an African author in a similar period of analysis. In our sample, they are only 4% of the researchers (116). Researchers based in Egypt may have had a more difficult time receiving emails that include surveys or links to surveys. A number of respondents commented that emails of such a nature are blocked by mail servers and firewalls^{iv}. In our research we will

assume that the characteristics of Egyptian researchers are similar to the characteristics of researchers in Northern Africa, and in our econometric model we will control for African regions.

Our main research question is focussed on studying the characteristics of the African researchers who engaged in collaborations with researchers outside of Africa. Therefore, it is important to examine in Fig. 3 what is the percentage of researchers who collaborate “very often”, “often”, “sometimes”, “rarely” and “never” with researchers from “outside of Africa”, “own institution”, “other institutions in own country” and “institutions in other African countries”.

Figure 3. Intensity of collaboration with four types of collaborators



Source: Own elaboration.

Not surprisingly, on average researchers collaborate most often with researchers from their own institution. Interestingly, it seems that on average the collaboration patterns of African researchers with researchers “outside of Africa” and “other institutions in own country” is very similar. And as expected, researchers in Africa collaborate more often on average with academics outside of Africa than with researchers from their own continent.

We also asked respondents about field of highest qualification and gender (see Fig. A1). The area with more researchers in our sample is “Natural Sciences” (32%) followed by “Medical and Health Sciences” (26%), “Social Sciences” (17%), “Agricultural Sciences” (13%) and “Engineering and Technology” (12%). About 30% of the researchers are female, with the percentage of females relatively higher for the subject areas “Social Sciences” (39%) and “Medical and Health Sciences” (37%), and smaller for “Engineering and Technology” (18%).

Since collaboration patterns may be different between subject areas and gender, in our regression analysis we will control for both dimensions.

Respondents also reported on the major challenges that have impacted negatively on their careers. On average, the biggest challenge is lack of funding, and the challenge that they reported as least relevant is “political instability” (see Fig. A2). More than 20% of the respondents also reported that “lack of training opportunities to develop professional skills”, “lack of mobility opportunities” and “lack of mentoring and support” have negatively impacted their career to a large extent. In our econometric analysis we will generate three dummy variables that are one for researchers who reported that “mentoring”, “mobility opportunities” and “research funding” were a challenge they faced “to a large extent”.

Finally, we also gathered bibliometric information on respondents’ academic age (defined here as 2017 – year of first publication in WoS) and scientific productivity (defined here as number of publications in WoS per academic age). The average academic age is 10 years and the average scientific productivity is 1.06 publications.

Econometric Results

We used StataTM to compute the multivariate ordinal probit. The regression model controls for scientific productivity, academic age, gender, subject area (5 of the 6 OECD categories): Natural Sciences, Agricultural Sciences, Engineering and Technology, Medical and Health Sciences, and Social Sciences; and also controls for regions: South Africa, Northern Africa^v and Central Africa^{vi}.

Table 1. Ordinal probit regression model

Ind. Variables	COL intensity outside Africa		
	oprobit I	oprobit II	oprobit III
Highest qualification (PhD) outside Africa (1 – Yes)	0.41*** (0.044)	0.53*** (0.074)	0.41*** (0.044)
Mobility abroad in the last 3 years (1 – Yes)	0.41*** (0.044)	0.40*** (0.044)	0.39*** (0.051)
Funding recipient in the last 3 years (1 – Yes)	0.14*** (0.045)	0.14*** (0.045)	0.14*** (0.045)
Share of international funding received in the last 3 years	0.0071*** (0.00059)	0.0071*** (0.00059)	0.0072*** (0.00059)
Lack of mentorship (1 – Yes “to a large extent”)	-0.11** (0.048)	-0.11** (0.048)	-0.11** (0.048)
Lack of mobility opportunities (1 – Yes “to a large extent”)	0.092* (0.049)	0.093* (0.049)	0.073 (0.059)
Lack of research funds (1 – Yes “to a large extent”)	-0.043 (0.046)	-0.044 (0.046)	-0.043 (0.046)
Female (1 – Yes)	0.044 (0.046)	0.043 (0.046)	0.043 (0.046)
Scientific productivity WoS	0.16*** (0.021)	0.16*** (0.021)	0.16*** (0.021)
Academic age WoS	0.012*** (0.0030)	0.016*** (0.0037)	0.012*** (0.0030)
PhD abroad x Academic age (Interaction)		-0.011** (0.0054)	
Mobility abroad x Lack of mobility opportunities (Interaction)			0.060 (0.097)
Constant cut1	-0.33*** (0.071)	-0.29*** (0.073)	-0.33*** (0.071)
Constant cut2	0.18** (0.071)	0.21*** (0.073)	0.18** (0.071)
Constant cut3	1.05*** (0.073)	1.09*** (0.076)	1.05*** (0.073)
Constant cut4	1.67*** (0.076)	1.70*** (0.079)	1.66*** (0.077)
Subject area effects	Yes	Yes	Yes
Regional effects	Yes	Yes	Yes
Observations	2,954	2,954	2,954
Pseudo R2	0.077	0.077	0.077
Wald chi2(16)	619		
Wald chi2(17)		622	619

Note 1: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Note 2: The intercept parameters are significantly different from each other so the five categories should not be combined into one.

Note 3: To complement this analysis, we carried out three different robustness checks. We computed an identical model using ordered logit regression; we computed our model using subject area groups, in order to check whether the results are consistent in all areas of knowledge; and we separated our observations in three African regions (South Africa, Northern Africa and Central Africa). In general, the results were consistent with this model.

Source: Own calculations.

In Table 1 we compute our regression using as dependent variable collaboration intensity outside of Africa. Model specification I is the original regression and model specifications II and III include interaction terms.

The first of our results indicates that researchers who did their highest qualification outside of Africa are more likely to be in a higher category of collaboration intensity outside Africa. A possible explanation is that African researchers who studied outside of Africa may expand their collaboration network, and upon returning to the continent, still maintained links with their research groups abroad. Our model confirms this hypothesis. A researcher that did his/her highest qualification outside of Africa is 11% more likely to be in the ‘very often’ category of collaboration outside of Africa, on average, than a researcher that did his/her highest qualification in an African country. However, when we interact this variable with academic age, the interaction term is negative and significant (II). This means that the connections gained during the PhD may lose importance during a researcher career.

Another variable that is positively and significantly associated with a higher category of collaboration intensity outside of Africa is “mobility in the last three years”. A researcher that has studied or worked abroad in the last three years before the survey is 11% more likely to be in the very often category of collaboration outside of Africa.

Being the primary recipient of research funding and receiving a higher share of international funding (being or not a primary recipient) are also positively and significantly associated with the likelihood of collaborating with researchers outside of Africa. Indeed, a researcher that receives 100% of their research funds from international sources is 20% more likely to collaborate very often with people outside of Africa than researchers who receive 0% of funds from international sources (on average). This indicates that collaboration often depends on the resource availability provided via international funding.

An interesting result is that different challenges faced during a career of a researcher seem to impact differently the likelihood of collaborating with researchers outside of Africa. For example, a researcher that reported that lack of mentorship was a challenge they faced “to a large extent” during their career is less likely to be in a higher category of collaboration intensity. A possible explanation is that younger researchers, who usually do not have access to all potential choices for initiating successful and fruitful collaborations, may depend on their mentors/supervisors to establish new collaborations. If their mentors/supervisors do not have access to an extensive research network or do not have the networking skills needed to introduce their students to other researchers, the young researchers may be penalized in the future. We are aware that a chronic problem in some African universities is the lack of qualified human resources for many teaching and training positions and therefore the availability of experienced researchers for supervision and mentoring is limited (Gaillard 2003). Yet, our results seem to

indicate that well targeted pedagogic support may play an important role in expanding a researcher's network.

On the other hand, the positive and significant sign of the coefficient of “lack of mobility opportunities” indicates that researchers who perceive they had lack of mobility opportunities are more likely to be in a higher category of collaborating intensity with researchers outside of Africa. At first glance, this is not intuitive since greater mobility usually is associated with more collaboration. However, this relation may happen because only the researchers who move frequently perceive that they have less mobility opportunities than their peers around the world. To test this hypothesis we interacted the dummy variable “lack of mobility opportunities” with the dummy variable “mobility in the last three years”. In specification III we can observe that the coefficient of “lack of mobility opportunities” is no longer significant at 10%. This means that indeed the positive and significant coefficient of “lack of mobility opportunities” in specification I is partially explained by the variable “mobility in the last three years”. Many of those who didn't move, may report they don't have lack of mobility opportunities because they do not care about mobility and don't see it as something important for them.

Conclusions

This chapter contributes to an understanding of the factors that allow some African researchers to collaborate more often with international partners than others. Data are taken from WoS and a survey that collected detailed information about the individual characteristics of 2954 African researchers in 42 African countries. Our research finds that doing the highest qualification (PhD) in a non-African country, recent international mobility and receiving a higher share of international funding is positively and significantly associated with higher collaboration intensity with researchers outside Africa.

One of the main results is that going abroad to do the highest qualification significantly expands your collaboration network outside of Africa. This result supports target 4b of the SDG that aims to increase scholarships available to low and middle-income countries. Our research also shows that the positive effect on collaboration of doing a PhD abroad diminishes over time. At the same time, researchers who were recently mobile are more collaborative. PhD scholarships should therefore not be limited to the time-period of the PhD, but should allow for additional travel and visiting opportunities post-PhD, to ensure that the networks are maintained or expanded. This could very simply be in the form of a few conference visits or other forms of research visits in the years following PhD graduation. What is important is that the gains that a

researcher has received from doing a PhD abroad should not be allowed to wither away so easily with time.

While there is value to foreign training, funders need to consider carefully to which universities they send PhD students, as not all foreign PhD training is equally useful. As argued by Müller et al. (2018) in the South African context, the gains obtained from going to a second tier foreign university may be smaller than going to a first tier local university. Furthermore, in this chapter we don't address the dangers of the "brain drain" or the lack of infrastructure and qualified human resources in many African universities. We are aware that this is a huge problem since some talented PhD students may not return to their home country. Therefore, beyond increasing the number of scholarships for student to go abroad, funders should also continue to develop foundations for research within Africa.

One possibility is for international donors to provide direct funding through research projects. Our work finds empirical evidence that researchers who received a higher share of international funding are collaborating more often with researchers outside of Africa. This was an expected result since several funding agencies, particularly government agencies, mandate cross-country collaboration as part of their funding conditions. However, what we don't explore in this chapter is if a higher share of international research funding increases the number of projects with societal relevance for the local populations and effectively enhances research capacity. In line with SDG goal 17, policies that wish to promote research collaboration should therefore also pay special attention to funding schemes and mechanisms that avoid "unequal partnerships" (Boshoff 2009; Gaillard 1994).

Several caveats must be kept in mind with regards to our study. First, we use a categorical, self-reported collaboration intensity dependent variable. This has some disadvantages in terms of the stability of the construct since certain researchers may perceive that they collaborate more often internationally than others, when objectively (e.g. co-authorships) this is not the case. However, in line with Duque et al. (2005) this approach may have certain advantages: 1) it can include collaborations that that did not involve publication; 2) it might exclude co-authors who achieved that status not by virtue of collaboration but because of influence and hierarchical position.

Besides that, the survey didn't include questions about the motives of collaboration or the dynamics of collaboration seeking. We also have no measures of quality of collaboration and the societal impact of those collaborations. Many researchers in African countries, when they do collaborate internationally, tend to participate in projects that have been conceptualized and designed in the "Global North" (Boshoff 2009). Who searches for whom and for what? How

many frequent collaborators do you have? Future surveys on this topic should probably include such questions.

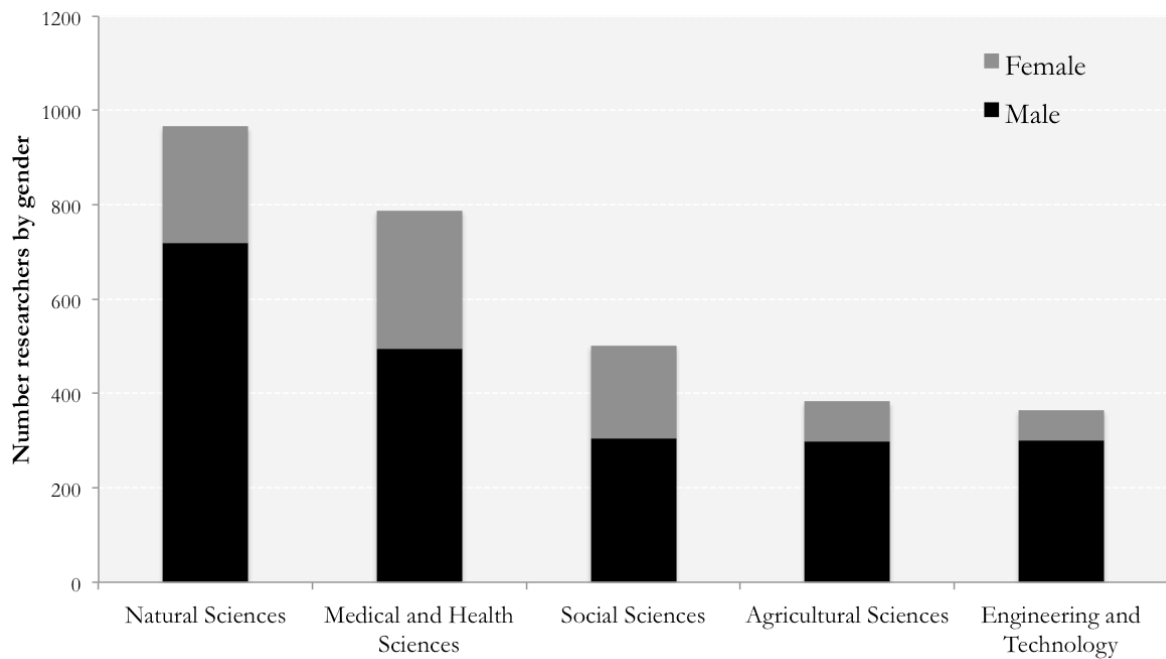
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Appendix

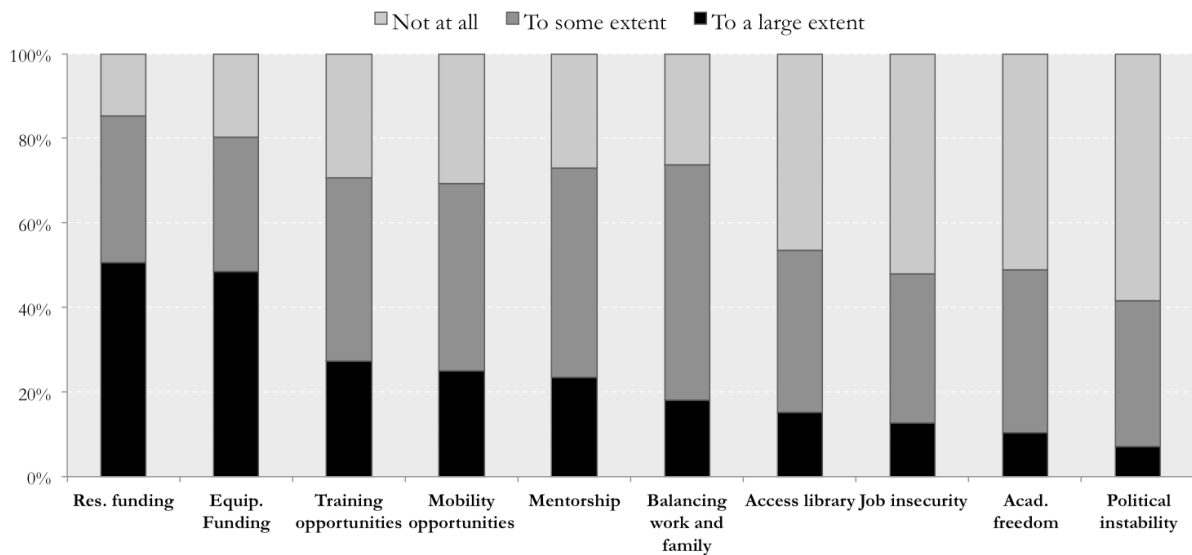
Figure A1. Number of researchers by area and gender



Source: Own elaboration.

Note: Humanities related fields were excluded due to the limitations of bibliometric indicators in this area.

Figure A2. Challenges faced during the career



Source: Own elaboration.

ⁱ Only authors that reported their email address in Web of Science or Scopus were contacted.

ⁱⁱ All African researchers who have a publication in WoS or Scopus between 2005 and 2015.

ⁱⁱⁱ We are not counting African researchers who work in a non-African country.

^{iv} Furthermore, some respondents mentioned the general suppression of academic freedom and access to information. However, these statements are based on specific comments from only a number of respondents.

^v Algeria, Egypt, Libya, Morocco and Tunisia.

^{vi} All African countries except South Africa and Northern African countries