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Internationally linked authors in Uganda, East Africa: An example of author-level bibliometrics for a developing country

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Introduction

It has been said that research progressed through different ages, which started with the individual, followed by the institutional and national, and that it is now in its fourth age (Adams 2013). The fourth age, according to Adams (2013, p. 557), is "driven by international collaborations between elite research groups". Adams further states that, "[i]nstitutions that do not form international collaborations risk progressive disenfranchisement, and countries that do not nurture their talent will lose out entirely" (Adams, 2013, p. 557). This cautionary remark has special relevance for developing countries as they often operate at the periphery of international research networks. A number of bibliometric studies are therefore paying close attention to the patterns of research collaboration in developing regions such as sub-Saharan Africa, as well as focussing on the reasons for and dynamics of collaboration (Adams et al. 2014; Boshoff, 2009, 2010; Ettarh, 2016; Onyancha & Maluleka, 2011; Owusu-Nimo & Boshoff, 2010; Pouris & Ho, 2014). The relevant bibliometric studies all used articles as the unit of analysis. However, individuals are the building blocks of teams, networks and the scholarly workforce of a country, which means that bibliometrics should also illuminate aspects of individual scholars. Individual-level bibliometrics is a recent phenomenon in research measurement and has not yet been applied, as far as could be established, to a developing country. The current study is therefore a first by focussing on internationally linked authors in Uganda in East Africa.

The paper starts with a brief overview of current research directions in the application of author-level bibliometrics, in order to position the study. In terms of the country under study, Uganda is very much reliant on foreign funding for research. In 2010, international sources accounted for 57% of the country's research funding, with government trailing in the second place (22%) (AOSTI, 2014). Because of inadequate research funding in Uganda, research consultancies and non-governmental organisations (NGOs) with a focus on research have started to grow. There is evidence that the consultancies are diverting senior university staff from academic research and stunting the institutional capacity of departments (Mamdani, 2011; Wright, 2008).

Research directions in the application of author-level bibliometrics

Discussions about individual-level bibliometrics follow one of four overlapping directions in the scholarly literature. The first is in the context of research evaluation, where the interest of evaluation is shifting from macro studies to increasingly lower levels of analysis, most

notably the individual and her/his research oeuvre (Glänzel, 2014). Studies following this direction use bibliometrics as one of many inputs in the evaluation of individuals.

The second research direction is about the statistical properties of bibliometric indicators at the individual level. The focus is on what each indicator expresses and the demands posed in terms of computation and data collection. For instance, Wilgaard, Schneider and Larsen (2014) reviewed 108 such relevant bibliometric indicators.

The third direction concerns the technicalities involved in creating unique author identifiers for individual-level bibliometrics. Reijnhoudt et al. (2014) introduced a semi-automated method, called 'seed + expand', to collect the whole publication oeuvre of a group of Dutch professors. Caron and Van Eck (2014) also contributed to the disambiguation of author names in large datasets by developing a special algorithm.

The fourth direction uses individual-level bibliometrics to investigate topics that appeal to science policy audiences as well as to those in the sociology of science. Examples include the classificatory scheme for Spanish researchers based on their research performance (Costas, Van Leeuwen & Bordons, 2010) and the identification of archetypes of economists based on ratios of published work and citations (Seiler & Wohlrabe, 2013). Sugimoto, Robinson-Garcia and Costas (2016) also applied individual-level bibliometrics in a study of research collaboration.

The current study is closest to the fourth research direction. The topic of researchers with strong international links is pertinent to current science policy, also in developing countries. However, in developing countries, researchers with strong international links potentially act as a double-edge sword. On the one hand, local researchers with international links could strengthen the research base of an institution or country while, on the other hand, they could leave the research base vulnerable should they migrate. The study therefore identified internationally linked authors by applying individual-level bibliometrics to a dataset of Ugandan articles. The focus was on four overlapping groups of internationally linked authors: (1) Ugandan authors with an international co-author, (2) Uganda authors with a joint international affiliation, (3) Ugandan authors affiliated with an international organisation that has a local address, and (4) Ugandan authors affiliated with an international research partnership. The following research questions guided the study:

- How are the four groups of internationally linked authors distributed across research fields, national sectors and selected organisations?
- What does the overlap between the four groups of internationally linked authors reveal about the importance of such authors for the Ugandan scholarly workforce?
- How do the four groups of internationally linked authors relate to measures of international and national mobility?

Methodology

The online version of the Web of Science (WoS) provided data for this study. Articles published between 2011 and 2015, and which included at least one Ugandan author address, were extracted from three citation indexes of the online Web of Science (Science Citation Index Expanded [SCI-Expand], Social Science Citation Index [SSCI], and Arts & Humanities Citation Index [A&HCI]). The date of extraction was 22 September 2017. The data was exported to a Microsoft Access database where it was systematically organised. This generated a dataset of 4,377 articles. Each article was assigned to one or more of four broad

research fields according to the field classification system of Boshoff (2010), which uses the subject category classification of journals in the WoS. These were agricultural sciences (AS), health sciences (HS), natural and engineering sciences (NES), and social sciences and humanities (SSH).

An authorship dataset of 49,522 records was also created, where each record represents an article-by-author address combination. Only for 142 records in this dataset an author name could not be linked to an address. Each Ugandan author address in the dataset was assigned to one of seven national sectors: higher education sector (HE), government sector (GOV), local international sector (LIO), non-governmental sector (NGO), international research partnership sector (IRP), private hospital sector (PHS) and industry (IND). The LIO sector refers to an international organisation with a Ugandan address or any Ugandan-based initiative of an international organisation that has a Ugandan address. Examples of such international organisations and initiatives with Uganda addresses are Basic Needs UK, Green Heat International, the Global Helmet Vaccine Initiative, the International Potato Centre, the World Bank, the World Health Organization, the Banded Mongoose Research Project of the University of Exeter in the United Kingdom, and the Fistula Care Project of EngenderHealth. The IRP sector involves explicit references in the address field to international research partnerships such as the Makerere University and John Hopkins University Research Collaboration, the Makerere University and the University of California San Francisco Research Collaboration, the Uganda Case Western Reserve University Research Collaboration, and the Infectious Diseases Research Collaboration.¹ The NGO sector included mostly non-governmental organisations registered in Uganda but also a few community-based and faith-based organisations. Public hospitals were included in the government sector.

Finally, a dataset of 3,948 Ugandan authors was created, summarising for each author relevant information from both the article and authorship datasets. The unification of author names and the assignment of unique authors codes occurred manually. The following information was recorded for authors from Uganda (UG) for the period 2011–2015:

- Number of articles by an author
- Broad research fields in which an author published (“yes/no” for each of four fields)
- Sectors in which an author published (“yes/no” for each of seven national sectors)
- Whether an author had at least one international co-author (“yes/no” – group 1: ICA)
- Whether an author reported at least one joint UG-international affiliation (“yes/no” – group 2: JIA)
- Whether an author had at least one address that is associated with a local international organisation (“yes/no” – group 3: LIO)
- Whether an author had at least one address that makes explicit reference to an international research partnership (“yes/no” – group 4: IRP)
- Whether an author had at least one UG-international mobility (“yes/no”)
- Whether an author had at least one national between-sector mobility (“yes/no”)

¹ The IRP sector, as operationalised in this paper, did not capture all Ugandan authors involved in international research partnerships. For instance, in terms of the Makerere University and John Hopkins University Research Collaboration, a Uganda author with the following address segment was classified as belonging to the Ugandan IRP sector: “*Univ MU JHU Res Collaborat, Kampala, Uganda*”. However, in cases where the relevant segment was absent but an author from John Hopkins University co-authored with an author from Makerere University, the Ugandan author at Makerere University was classified in the ICA category (international co-author).

Some clarifications are warranted. A joint UG-international affiliation means that an author reported both a Ugandan and an international address in the same article. A UG-international mobility means that an author reported a Ugandan address in one article and an international address in another. When determining whether an author had at least one UG-international mobility, instances of joint UG-international affiliations (involving the relevant mobility organisations) were ignored. National between-sector mobility means that, in one article, an author reported an address in one sector (e.g. higher education) but, in another article, an address in another sector (e.g. NGO sector). Instances where an author listed more than one Ugandan sector in the same article were not classified as national mobility but as joint national sector affiliation.

Results

The results are presented according to the three research questions of the study.

Distribution of four groups of internationally linked authors across research fields, national sectors and selected organisations

Table 1 shows each of the four groups of internationally linked authors as a percentage of the total number of Ugandan authors and as a percentage of the total number of authors in each field, sector and organisation. The two Ugandan organisations included are the largest in their respective sectors (Makerere University [MU] in HE, and the Ministry of Health [MoH] in GOV). Tests of statistically significant group differences could not be performed because of the non-independence of groups. About 83% of all Ugandan authors are linked internationally through international co-authorship, and 18% reported a joint international affiliation in one or more of their articles. The sector breakdown shows that only 11% of the 46 Ugandan authors in industry had a joint international affiliation compared with 29% of the 226 authors in the national IRP sector. Moreover, 93% and 92% of authors in the IRP and NGO sectors have at least one international co-author whereas the figure for authors in higher education is markedly lower at 79%. The profiles for the agricultural sciences and the health sciences are strikingly similar in terms of shares of international co-authors (85%) and joint international affiliations (17-18%). However, authors in the natural and engineering sciences reported more international affiliations compared to authors in the other fields (23% vs. 17-18%). Although the social sciences and humanities also had markedly fewer authors reporting international co-authorship (76% vs. 85-88%), the figures for co-authorship nevertheless remain high across all fields.

The four overlapping groups of authors were combined into a single variable comprising 14 mutually exclusive categories. Table 1 shows the number of Ugandan authors in each category together with the share of articles produced by that category. The article counts are not mutually exclusive. Although less than 1% of authors met all four criteria for an internationally linked author, they accounted for 7% of the total article output during the relevant period and were the most productive of all authors (26 articles per author, on average, over the five-year period). The second group of most productive authors (5.6 articles, on average) were those associated with all three of the following criteria for international linkages: an international co-author, a joint UG-international affiliation and an association with a local international organisation.

Table 1. Percentages of internationally linked Ugandan authors (four groups), by broad research field, sector and organisation, 2011–2015.

	Overall	Broad research fields				UG sectors							UG organisations	
		HS	NES	SSH	AS	HE	GOV	LIO	NGO	IRP	PHS	IND	MU	MoH
All UG authors	3,948	2,506	1,148	525	503	2,044	1,221	580	304	226	162	46	1,775	869
Group 1 (ICA): UG authors with at least one international co-author as % of all UG authors	83%	85%	88%	76%	85%	79%	88%	89%	92%	93%	83%	91%	79%	91%
Group 2 (JIA): UG authors reporting at least one joint UG-international affiliation as % of all UG authors	18%	17%	23%	17%	18%	19%	18%	23%	13%	29%	20%	11%	20%	17%
Group 3 (LIO): UG authors associated with at least one local international organisation as % of all UG authors	15%	14%	16%	15%	20%	5%	8%		4%	13%	3%	2%	6%	8%
Group 4 (IRP): UG authors associated with at least one international research partnership as % of all UG authors	6%	8%	8%	2%	0.4%	3%	3%	5%	4%		0%	0%	9%	5%

Note: Group 3 has no corresponding figure for the local international sector (LIO) because the group comprises all authors in that sector (percentage would be 100%). Similarly, Group 4 has no corresponding figure for the international research partnership sector (IRP) because it includes all of the relevant sector's authors (100%)

Table 2. Ugandan authors and their article output by author category, 2011–2015.

Author categories	UG authors		UG articles		Average articles per author category
	Count	As % of 3,948 authors	Count	As % of 4,377 articles	
All four	12	<1%	315	7%	26.3
ICA, JIA & LIO	102	2%	569	13%	5.6
ICA, IRP & LIO	18	<1%	91	2%	5.1
ICA & JIA	469	12%	1,946	44%	4.1
ICA, IRP & JIA	46	1%	188	4%	4.1
ICA & IRP	134	3%	271	6%	2.0
ICA & LIO	387	10%	643	15%	1.7
ICA only	2,109	53%	2,909	66%	1.4
JIA only	43	1%	56	1%	1.3
LIO only	43	1%	39	1%	0.9
IRP & JIA	8	<1%	7	<1%	0.9
None	551	14%	382	9%	0.7
IRP only	8	<1%	3	<1%	0.4
JIA & LIO	18	<1%	8	<1%	0.4

Importance of internationally linked authors for the Ugandan scholarly workforce

In order to establish the importance of internationally linked authors for the Ugandan scholarly workforce, the four groups of authors were removed stepwise from the total set of Ugandan authors (Table 3). The two largest groups (ICA and JIA) were removed first. Table 3 shows that only 17% of the 3,984 Ugandan authors remain when those with international co-authors are excluded. This percentage slightly decreases to 15% when authors associated with joint international affiliations are also removed. Finally, only 14% of authors remain once Ugandan authors in the LIO and IRP sectors are accounted for. The same exercise was repeated for the four fields, six sectors and two organisations. It appears that the NGO sector in Uganda is particularly reliant on internally linked authors for its scholarly workforce because only 7% of its authors are not linked internationally.² The higher education sector (which includes Makerere University) is the least reliant on internationally linked authors (19% of authors remain after extracting those who are linked internationally).

However, even though 14% of all Ugandan authors are not linked internationally they could still be linked so indirectly. One possibility is through national collaboration (co-authorship) with other internationally linked Ugandan authors. Table 4 shows the percentages of internationally non-linked Ugandan authors who co-authored articles with internationally linked Ugandan authors. Accordingly, 74% of the 551 Ugandan authors without any international links co-authored articles with Ugandan authors who are linked internationally. For the Ministry of Health (and also for agricultural sciences), the figure is as high as 86%. Read together with Table 3, it means that although 8% of the scholarly workforce in the Ministry of Health have no direct international linkages, 86% of those that comprise the 8% still have indirect international linkages. Indirect international linkages seem to be less so in the case of the social sciences and humanities.

² Although the percentages in stage 4 for the LIO and IRP sectors are zero, these do not require further attention because two of the criteria for internationally linked authors (groups 3 and 4) are completely defined in terms of these two sectors. The zero percentages are thus self-explanatory.

Table 3. Percentages of Ugandan authors remaining after excluding four groups of internationally linked authors.

	Overall	Broad research fields				UG sectors							UG organisations		
		HS	NES	SSH	AS	HE	GOV	LIO	NGO	IRP	PHS	IND	MU	MoH	
All UG authors	3,948	2,506	1,148	525	503	2,044	1,221	580	304	226	162	46	1,775	869	
Stage 1	Minus: Group 1 (ICA)	3,277	2,136	1,010	401	426	1,615	1,074	519	280	210	135	42	1,406	789
	UG authors remaining	671	370	138	124	77	429	147	61	24	16	27	4	369	80
	<i>As % of all UG authors</i>	17%	15%	12%	24%	15%	21%	12%	11%	8%	7%	17%	9%	21%	9%
Stage 2	Minus: Group 2 (JIA)	69	32	21	23	3	31	12	18	0	8	3	0	30	7
	UG authors remaining	602	338	117	101	74	398	135	43	24	8	24	4	339	73
	<i>As % of all UG authors</i>	15%	13%	10%	19%	15%	19%	11%	7%	8%	4%	15%	9%	19%	8%
Stage 3	Minus: Group 3 (LIO)	43	23	8	9	8	6	4	43	0	0	0	0	5	0
	UG authors remaining	559	315	109	92	66	392	131	0	24	8	24	4	334	73
	<i>As % of all UG authors</i>	14%	13%	9%	18%	13%	19%	11%	0%	8%	4%	15%	9%	19%	8%
Stage 4	Minus: Group 4 (IRP)	8	8	0	0	0	1	0	0	3	8	0	0	5	0
	UG authors remaining	551	307	109	92	66	391	131	0	21	0	24	4	329	73
	<i>As % of all UG authors</i>	14%	12%	9%	18%	13%	19%	11%	0%	7%	0%	15%	9%	19%	8%

Table 4. Percentages of internationally non-linked Ugandan authors who collaborate nationally with other internationally linked authors.

	Overall	Broad research fields				UG sectors							UG organisations		
		HS	NES	SSH	AS	HE	GOV	LIO	NGO	IRP	PHS	IND	MU	MoH	
UG authors not linked internationally	551	307	109	92	66	391	131	0	21	0	24	4	329	73	
% collaborating with ...															
UG author in Group 1 (ICA)	74%	85%	79%	30%	86%	73%	79%	--	67%	--	79%	25%	76%	86%	
UG author in Group 2 (JIA)	31%	40%	30%	4%	27%	34%	31%	--	24%	--	13%	25%	36%	42%	
UG author in Group 3 (LIO)	17%	21%	13%	7%	21%	15	28%	--	5%	--	8%	25%	15%	33%	
UG author in Group 4 (IRP)	7%	9%	6%	3%	0%	7%	8%	--	0%	--	4%	25%	9%	14%	
UG author in any group above	74%	85%	79%	30%	86%	73%	79%	--	67%	--	79%	25%	76%	86%	

Relation between three groups of internationally linked authors and measures of international and national mobility

The 551 internationally non-linked authors were assigned to one of two categories: those with indirect international linkages and those without any international linkages. Together with the 3,397 Ugandan authors with direct international linkages, a new variable was created consisting of three mutually exclusive author categories. Table 5 reports for each of the categories the percentage of authors with international and national mobility. The percentages of international mobility, although low, do vary by the category of author. It is highest for authors with direct international linkages (5%). Authors with international mobility are those who listed a Ugandan address in one article and an international address in another (but excluding cases where the two addresses form part of that author’s joint international affiliation). National mobility (i.e. Ugandan authors listing different national sectors in different articles) was found to be generally higher than international mobility – 13% (458) of the directly internationally linked authors reflect at least one national mobility. As a matter of interest, Table 5 also reports the percentage of Ugandan authors with a joint national sector affiliation. This refers to authors who listed different Ugandan sectors in the same article.

Table 5. Percentage of international and national mobility across three categories of Ugandan authors.

Author categories	Number of authors	Mobility		% joint national sector affiliation
		% international mobility	% national (between-sector) mobility	
UG authors with direct international linkages	3,397	5%	13%	2%
UG authors with indirect international linkages	407	1%	2%	1%
UG authors with no international linkages	144	1%	1%	3%
Total	3,948	5%	12%	2%

Table 6 takes a closer look at the 458 authors with direct international linkages who reflect at least one national mobility. The focus is on the pattern of national mobility across sectors. For instance, 352 authors published at least one article using an address in higher education. Of those, 63% also published at least one other article with an address in government and 26% an address that is associated with an international organisation in Uganda. In any of the six non-higher education sectors, more than half or even as high as 75% of authors (GOV & IND) are also to be found in the higher education sector.

Table 6. Pattern of national (between-sector) mobility of UG authors with direct international linkages, 2011–2015.

	% of 352 authors in HE who are	% of 297 authors in GOV who are	% of 168 authors in LIO who are	% of 67 authors in NGO who are	% of 83 authors in IRP who are	% of 38 authors in PHS who are	% of 8 authors in IND who are
Also in HE	--	75%	55%	64%	66%	66%	75%
Also in GOV	63%	--	52%	37%	43%	29%	0%
Also in LIO	26%	29%	--	16%	35%	13%	13%
Also in NGO	12%	8%	7%	--	12%	18%	0%
Also in IRP	16%	12%	17%	15%	--	0%	0%
Also in PHS	7%	4%	3%	10%	0%	--	13%
Also in IND	2%	0%	1%	0%	0%	3%	--

Concluding remarks

This bibliometric study of Ugandan authors showed international co-authorship to be the most prominent form of international linkages. The most productive Ugandan authors were the extremely small group who reported all four forms of international linkages. The study also showed that without the identified forms of international linkages, the Ugandan scholarly workforce would reduce to only 14% of its current size. A significant share (74%) of the authors to remain (after accounting for the internationally linked authors) most probably had entered the scholarly workforce through collaboration with other Ugandan authors who are linked internationally (e.g. in a student-supervisor relationship). Although the overall extent of international and national mobility associated with internationally linked authors appears to be low (5% and 12%), it nevertheless requires attention given that only a five-year period of analysis applies. The figures also require benchmarking against comparative figures for other countries in sub-Saharan Africa.

Ideally, segments of authors identified in the bibliometric analysis should be followed up on through other research methods (surveys and interviews), in order to develop a nuanced understanding of the four groups of internationally linked authors and the two measures of mobility in the context of Uganda. Moreover, small country-specific author-level datasets, like the current, could help to validate the performance of existing algorithms used to uniquely identify article authors in large datasets.

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