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Productivity in academia

An assessment of causal linkages between output and outcome indicators

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Abstract

Purpose – The purpose of this paper is to investigate causal linkages between output and outcome indicators of productivity in academia.

Design/methodology/approach – The duration of teaching service and the number of graduate students supervised to completion were adopted as output indicators of productivity. Equivalent outcome indicators were the number of (co)authored books (including book chapters and monographs) and journal articles, respectively. In the investigations, a structural equation modeling approach was adopted.

Findings – The number of students supervised to completion directly impact the number of (co)authored articles ($p < 0.05$). The duration of teaching service indirectly influences (co)authored articles by directly impacting the number of students supervised to completion ($p < 0.05$).

Research limitations/implications – The causal linkages between the indicators of productivity are an indication of the level of research activity of academia. However, the study does not provide an exhaustive assessment of all indicators of productivity in academia.

Originality/value – Unlike literature on the subject area that is focused on factors influencing productivity in academia, this study demonstrates casual relationships between the indicators of productivity.

Keywords Academic staff, Performance indicators, Productivity

Paper type Research paper

Introduction

Productivity in academia is consensually regarded as an indicator of research activity conducted by individuals, institutions, countries and regions as a whole. However, the contentious issue is whether to assess productivity with regard to (i) quantity or quality, (ii) outputs or outcomes or (iii) a combination of (i) and (ii). In other words, would productivity of academic staff be assessed with regard to the number of students they have supervised to completion or the number of (co)authored articles published? Similarly, would it be appropriate to attach more importance to the duration of teaching service compared to the number of (co)authored articles, books, book chapters and monographs? Further, it is questionable whether productivity in one dimension could be used as a basis for explaining productivity in another. In providing an explanation to the contentious issues, it is important to establish an understanding of the various roles of academic staff. Winfred (2013) presents three major roles of academia:

(1) duties of instruction – preparing, advising, exam correcting, providing remedial help and related aspects;

(2) scholarly obligations through research and contribution in peer-reviewed journals and books; and

(3) community service.

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It must be noted that the second and third obligations go beyond the eight-hour workday schedule of bureaucrats. In light of the staffing deficits, particularly among institutions in the developing countries (Tettey, 2008), the duties of instruction certainly leave no time for scholarly obligations and community services. Affirming the demands of the duties of instruction, Winfred (2013) argues that each hour of lecturing is multiplied by a factor of three to reflect the hours of preparation, advising, exam correction, remedial help and other related aspects. To this end, attaching importance to productivity measured by the duration of teaching service would be justified. However, the debatable aspect is whether the international community of scholars would find the duration of teaching a better measure of productivity in academia when compared to scholarly productivity – (co)authored articles and books, book chapters and monographs.

One of the requirements for a teaching position in many academic institutions is a doctoral certification. Usually, the position does not usually require prior supervision of students, scholarly productivity, teaching experience and contribution to community. However, promotion to subsequent ranks (senior lecturer, associate professor and professor) requires a certain level of productivity in the aforementioned aspects. Nevertheless, faculty in academia is uniquely positioned as an intermediary among the students, institutions and countries they service. They are at the core of research and often guide students in the preparation and completion of their research reports. The efforts of academic staff are recognized not only by academic institutions but also by the students they serve. In particular, students are required to acknowledge the contributions of members of their research teams in all publications and conference presentations. Thus, it is no surprise that supervisors (usually academic staff) are co-authors of scholarly publications emerging from students' theses and dissertations as they contribute substantially to research and development of journal articles in particular. However, the order of (co)authors listed (students and their supervisors) may vary by institutions and depend on the level of contribution to a scholarly manuscript. Nevertheless, an argument of a relationship between the number of students supervised to completion and the number of (co)authored articles would have substantial support. However, the argument may not hold for all academia mainly because of the low importance accorded to scholarly productivity in some institutions. For example, the 2012 release of Scimago Institutions Rankings (SIRs) regarding the total number of documents published in scholarly journals indexed in Scopus shows that world research output rankings are commanded by the developed wealthy world – Western Europe and North America (SIR, 2012). The share of publication output in Africa falls far lower than the rest of the world (UNESCO, 2010; Yonge *et al.*, 2005; Muula, 2007). The web-metrics ranking of world universities, partly based on academic papers published in high-impact international journals, do not reveal otherwise regarding Africa's level of scholarly productivity.

On the contrary, academia in many developing countries is considered to be productive with regards to the supervision of students. For example, a recent Careers and Productivity of Doctoral Holders (CDH) Survey in Uganda indicates high productivity of doctoral degree holders with regard to the teaching and supervision of students (UNCST, 2012). Certainly, the academic staff who have served longer will have more years of teaching and students supervised to completion compared to their counterparts who are new in the field. Although these academic staff may be considered highly productive by their local institutions, the international community is more likely

to conclude otherwise in the absence of scholarly productivity. The fact that dissertation/thesis reports are rarely indexed in internationally recognized scholarly databases implies that a substantial amount of quality research output goes widely unrecognized in many developing countries. Thus, the low ranking of academic institutions in many African countries may not necessarily imply a dearth of quality research undertaken but, rather, low emphasis accorded to scholarly productivity. In other words, academicians in many institutions are not compelled to have scholarly publications. This, however, is not the case with regard to the output measures of productivity. As a matter of fact, academic staff do not usually have a choice on whether or not to supervise/teach students.

Available literature provides insights into the levels and determinants of productivity in academia, both locally (Mugimu *et al.*, 2009; Wamala and Ssembatya, 2013; UNCST, 2012) and internationally (UNESCO, 2010; Tettey, 2008; Yonge *et al.*, 2005; Muula, 2007). However, these studies are limited in explaining causal relationship (if any) between the indicators of productivity. In other words, the aspect of whether the number of students supervised to completion impacts on (co)authored articles and books (including monographs and book chapters) or vice-versa remains uninvestigated. A similar concern is raised regarding the impact of duration of teaching service on scholarly productivity and/or vice versa. This article is based on the argument that the indicators of productivity must be related in a highly productive academic environment.

Theoretical grounding on productivity in academia

The review in the subsequent sections is based on indicators of productivity, factors that determine productivity and causal linkages between the various indicators of productivity in academia. A review of the determinants of productivity in academia is important in providing an understanding of factors that may impact the statistical significance of casual relationships established in the assessment. Worth noting is the fact that some of the factors are external to the conceptualized model.

In their 2006 study, Bland, Center, Finstad, Risbey and Staples present seven major indicators of productivity in academia. These are grants, (co)authored journal articles, (co)authored books, presentations, tenure/promotions, effective teachers and committed faculty. The indicators are in their study influenced by three major factors:

(1) individual faculty member;

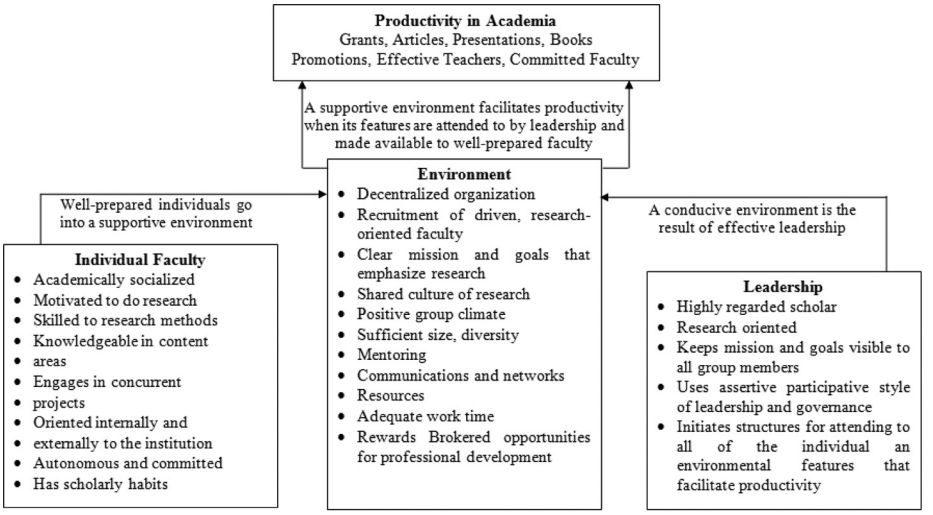
(2) conducive work environment; and

(3) effective leadership.

Figure 1 presents an illustration of these factors.

In an extensive review of literature, Jung (2012) does not show otherwise regarding the factors that influence research productivity of academia. Contrary to Bland *et al.* (2006), Jung (2012) summarizes the factors by four major themes, namely, individual attributes, previous experience (training, reputation of doctoral program and post-doctoral experience), institutional characteristics and discipline area.

Particularly, demographic characteristics are individual attributes that are consensually considered to influence productivity in academia (Bland *et al.*, 2006; Fabel *et al.*, 2008; Jung, 2012; Sheehan and Welch, 1996; Wamala and Ssembatya, 2013). Academic level experience, measured by age, is considered to be one of the most important demographic factor that influences productivity in academia (Jung, 2012). As



Source: Adapted from Bland *et al*. (2006)

Figure 1.
Factors that influence research productivity in academia

age usually correlates positively with academic rank, the latter variable could as well be adopted as a measure of academic experience. It should not, therefore, be surprising that senior academic staff (e.g. Professors, Associate Professors), who are usually older in age, are likely to be more scholarly productive than their counterparts at the lower academic ranks. Another measure of academic experience is the "career age". It is measured by the number of "years in academic after one receives advanced academic credentials, usually a doctorate" (Jung, 2012, p. 3). Literature points to a negative relationship between career age and (co)authored journal articles (Fabel *et al.*, 2008).

Workload, measured by time devoted to academic activities, influences research productivity of academia (Winfred, 2013; Teodorescu, 2000). Unlike a negative relationship between time spent on teaching and research productivity, Teodorescu (2000) argues that time spent on research correlates positively with research productivity. However, the duties of instruction, including supervision of graduate and undergraduate students, usually leave no time for scholarly obligations (Dundar and Lewis, 1998; Winfred, 2013). The situation is made worse in institutions were student enrollment figures are not matched by equivalent staffing levels. This is a characteristic of the situation in many academic institutions in developing countries (Tettey, 2010). The deficits demonstrate a large gap in the human resource capacity of academia in these institutions. Consequently, the shortfalls point to a low ability of the existing academic staff to carry out research and teaching responsibilities. On the contrary, Jung (2012) argues that a high ratio of graduate workload may positively impact research productivity. The argument is that students and faculty are able to co-publish their findings through collaborative research. Large student enrollment figures are, from this perspective, viewed as a contributing factor to a richer environment of scholarships, research projects and seminars (Wood, 1990; Mugimu *et al.*, 2009). Particularly, science disciplines are noted to have a wider variety of funding sources for research compared to the arts/humanities (Mugimu *et al.*, 2009). This, therefore, allows for academic

workshops and seminars in the sciences which create opportunities for networking with colleagues across academic institutions. Thus, a significantly higher number of (co)authored journal article of academia in the science disciplines (Jonathan *et al.*, 2010; Jung, 2012; Wamala and Ssembatya, 2013) should not be surprising.

The aforementioned factors do not exist in isolation. Research productivity is influenced by the social and organizational context in which they occur (Bland *et al.*, 2006; Fox, 1983; Finkelstein, 1984; Mugimu *et al.*, 2009). In affirming to the influence of institutional factors, Bland *et al.* (2006) argues that a supportive environment facilitates productivity when its features are attended to by leadership and made available to well-prepared faculty. Bland *et al.* (2006) presents 12 institutional and/or environmental factors that influence productivity in academia. These are as follows: clear mission and goals that emphasize research, recruitment of research driven faculty, shared culture of research, positive group climate; decentralized organization, communication and networks, accessible resources; sufficient size and diversity of the research group, appropriate rewards or opportunities for professional development, mentoring and adequate work time. On the other hand, Jung (2012) presents performance-based management as one of the main institutional factors that promote productivity in academia. The approach uses a reward system, including tenure, promotion, salary increments and other financial support for faculty members based on their productivity. In citing Braxton *et al.* (2002) and Fairweather (1992), Jung (2012) suggests that the approach of performance-based management influences promotion decisions, reinforce future academic research and attract more research funds.

The aforementioned review provides a detailed explanation to factors that determine productivity in academia. However, the literature is limited in providing an understanding of causal relationships between the indicators of productivity in academia. Thus, the analysis in this paper attempts to address this shortfall.

Data and methods

This study is based on secondary data sourced from the 2012 CDH Survey conducted by the Uganda National Council for Science and Technology (UNCST) (UNCST, 2012). The Council is mandated to facilitate and coordinate the development and implementation of policies and strategies for integrating Science and Technology into the national development process. The council undertook a study to establish demographics of doctoral degree holders in the country and their patterns of employment. The study population comprised doctoral degree holders aged 70 or below (graduation cohorts in the period 1990-2010) as of December 2010 and living permanently or domiciled in Uganda. The population of doctorate holders was drawn from the databases of universities for doctorate holders, university academic staff registers and libraries (PhD theses), UNCST databases of researchers and research groups, government department registers, Ministry of Education and Sports (MoES), and professional and alumni association memberships. Based on a cross-sectional design, primary data were obtained from the sample of 534 doctoral degree holders using questionnaires. However, investigations in this article are based on doctoral degree holders who had (co)authored journal articles ($n = 149$) and books ($n = 108$) as well as those who had supervised graduate students to completion ($n = 140$). The duration of teaching service (career age) was assessed for these doctoral degree holders. These measures are, however, not an exhaustive list of all indicators of productivity in academia. The study was restricted to

these indicators of productivity mainly on the account of limitations of secondary data adopted in the investigations. Nevertheless, productivity based on these measures is only possible for doctoral degree holders in academia.

The indicators of productivity were summarized by two broad categories:

(1) output indicators, comprising duration of teaching service or career age (YT) and the number of graduate students (Master's and Doctoral) supervised to completion (SS); and

(2) outcome indicators comprising (co)authored journal articles (JA) and books, including book chapters and monographs (MN).

In particular, the period from completion of doctoral studies to the time of the survey was adopted as a measure of the duration of teaching service. This is because a doctorate degree is consensually regarded as the minimum requirement for one to fully qualify as a "Lecturer" in an academic university (Makerere University, 2009). The assessment is focused on establishing causal linkages or relationships between the aforementioned indicators of productivity. However, the study is limited in providing an understanding of the quality of these indicators of productivity.

Figure 2 represents a conceptual model demonstrating the hypothesized casual relationships between the indicators of productivity. In the model, variable YT is exogenous, while variables SS, JA and MN are endogenous. Unlike the endogenous variables (SS, JA and MN), the determinants of the exogenous variables (YT) are not explicitly presented in the system or model. The exogenous variable(s) in the model is an independent variable (IV), while the endogenous variables could be both independent and dependent variables (DV). For example, YT is suggested to be a cause of SS, but SS is presented in the system as a cause of JA.

According to Figure 2, the structural equations (excluding intercepts) are as follows:

$$SS = \beta_{21} YT + \varepsilon_2 \tag{1}$$

$$MN = \beta_{31} YT + \varepsilon_3 \tag{2}$$

$$JA = \beta_{41} YT + \beta_{42} SS + \beta_{43} MN + \varepsilon_4 \tag{3}$$

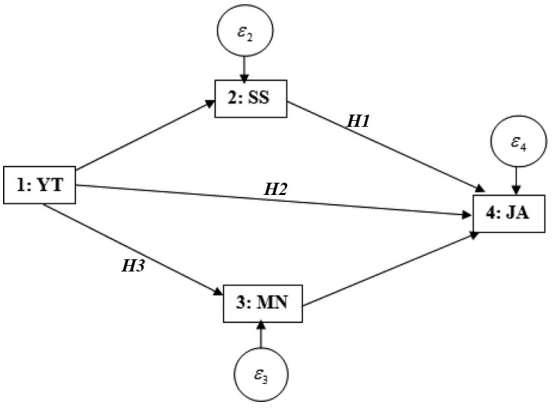


Figure 2.
Conceptual model of causal linkages between indicators of productivity in academia

where β_{ij} denotes path coefficients – the first and second subscripts represent dependent and independent variables, respectively; ε_i represent error terms – these are a special type of latent exogenous variables.

In equation (1), the number of students supervised to completion is predicted by years of teaching service. The number of (co)authored books, including book chapters and monographs, is explained by the years of teaching service according to equation (2). In equation (3), the number of (co)authored journal articles is predicted by years of teaching service, students supervised to completion and (co)authored books, including book chapters and monographs. The main hypotheses investigated in the system were as follows:

- the number of students supervised to completion directly influences the number of (co)authored journal articles (*H1*);
- a longer duration of teaching service is directly associated with a greater number of (co)authored articles (*H2*); and
- a longer duration of teaching service is directly associated with a greater number of (co)authored books (including book chapters and monographs).

This study suggests that in a highly productive academic environment, these hypotheses should be supported. These hypotheses were investigated by conducting an analysis using structural equation modeling (SEM). Particularly, the analysis was based on SEM using a maximum likelihood (ML) estimation approach with missing values. A one-way causal relationship flow between the indicators of productivity was assumed. The one-way arrows in the model represent the direct effect – the structural effects. A fitted SEM was investigated for appropriateness using the following:

- overall model fit based on the likelihood ratio (LR) Chi-square test;
- incremental fit indices – the comparative fit index (CFI); and
- residual-based indices – root mean square error of approximation (RMSEA).

Associations in the investigations were established at 5 per cent and 1 per cent significance levels, unless stated otherwise.

Results

The results of this study are based on a sample of doctoral degree holders who (co)authored journal articles and/or books (including book chapters and monographs) as well as those who had supervised graduate students to completion. The characteristics of these doctoral degree holders can be summarized as followings: predominantly male (80.0 per cent); involved in science disciplines (76.3 per cent); the highest proportion constituted doctorate graduates of international universities (49.1 per cent), followed by Ugandan universities (34.2 per cent), while the rest obtained their PhDs from other African Universities. The median age of the doctorate holders is 46 years (range, 32-67).

Descriptive summary of output and outcome indicators

Table I presents summary statistics of output and outcome indicators of productivity of the doctoral degree holders assessed in the study.

With regard to output indicators, the median duration of teaching service is seven years (range, 1-39), while the number of students supervised to completion is 10 (range, 1-74). With

regard to the outcome indicators, the median number of (co)authored books and articles was 3 (range, 1-20) and 8 (range, 1-50), respectively. These results indicate a relatively higher productivity of output compared to outcome indicators of productivity.

Relationship between indicators of productivity

Tables II and III present the correlation and path analysis estimates, respectively, and reveal the relationships between the indicators of productivity. A summary of the results is provided subsequently.

Indicators of productivity	*n*	Minimum	Maximum	Median
Output				
Duration of teaching (years)	149	1	39	7
Supervised students	140	1	74	10
Outcome				
(Co)authored books[a]	108	1	20	3
(Co)authored journal articles	149	1	50	8

Notes: Summary relates to PhD holders with at least an indicator of productivity; [a]including book chapters and monographs

Table I. Summary statistics of output and outcome indicators of productivity

Indicators	1	2	3	4
1. (Co)authored articles	**1.0**			
2. (Co)authored books	0.267*	**1.0**		
3. Duration of teaching	0.213*	0.065	**1.0**	
4. Students supervised	0.228*	0.019	0.343**	**1.0**

Notes: Assessment is based on Pearson correlation; where $*p < 0.05$; $**p < 0.01$; The bold (i.e. 1.0) implies that it is the same indicator (or variable) assessed in the row and column

Table II. Indicator inter-correlations

Dependent variable	Independent variable	β[a]	Standard error[b]	*p*-value
(Co)authored books				
	Duration of teaching	0.072	0.093	0.437
	_cons	0.924	0.174	0.000
Students supervised				
	Duration of teaching	0.326	0.070	0.000
	_cons	0.535	0.143	0.000
(Co)authored Articles				
	Students supervised	0.185	0.081	0.024
	Duration of teaching	0.120	0.083	0.145
	(Co)authored books	0.250	0.091	0.006
	_cons	0.571	0.169	0.001

Notes: Assessment is based on SEM; where LR $Chi^2 = 0.04$; $p = 0.849$; RMSEA = 0; CFI = 1.0; [a]denotes coefficients; [b]denotes standard errors based on Observed Information Matrix (OIM)

Table III. Regression estimates

In the results presented in Table II, significant correlations are established among several indicators of productivity. However, in the logic of causal order, the associations established say little regarding the causal linkages between these indicators of productivity. In light of this limitation, SEM results in Table III provide an explanation to the causal relations between the indicators of productivity assessed in this study. SEM diagnostic tests show good fit of the model:

- the incremental fit index estimate is within the acceptable limits (CFI > 0.9) of a good fitted model (Lance *et al.*, 2006);
- the residual based index estimate (RMEA < 0.05) shows that the model is a perfect fit (Chen *et al.*, 2008; Browne and Cudeck, 1993); and
- results of the LR Chi-square test do not reveal otherwise with regard to the fit of the model ($p > 0.05$).

In light of the appropriateness of adopting the generated model in the investigation, Table IV presents a summary of results regarding causal relationships established between the indicators of productivity.

According to the summary in Table IV, the hypothesis of a positive linkage between the number of students supervised to completion and (co)authored articles *H1* was supported ($p < 0.05$). In contrast, the hypotheses of a relationship between duration of teaching service and the number of (co)authored books (*H2*), as well as duration of teaching service and the number of (co)authored articles (*H3*), were not supported ($p > 0.05$). Thus, the results in Tables II and III show both direct and indirect correlations between the indicators of productivity.

Discussion

The findings demonstrate direct and indirect relationships between output and outcome measures of productivity in academia. Particularly, a rejection of *H3* implies no direct impact of the duration of teaching service (career age) on the number of (co)authored articles. However, a significant association in the results between the number of students supervised to completion and the number of (co)authored articles implies a direct impact of the latter on the former. Thus, the duration of teaching service indirectly impacts number of (co)authored articles by directly influencing the number of students supervised to completion. The fact that one out of the three hypotheses were supported in the results suggests the presence of mediating factors that may impact the model. This evidence should not be surprising in the assessment using SEM as the determinants of the exogenous or independent variables are never explicitly presented in the system (Browne and Cudeck, 1993; Chen *et al.*, 2008). As the endogenous factors in the system are both independent and dependent variables, supports the argument regarding the impact

Table IV. Summary of causal relationships and/or hypotheses investigated

Model path	Hypotheses	Comment
Students supervised → (Co)authored articles	*H1*	Supported
Years of teaching → (Co)authored books	*H2*	Not supported
Years of teaching → (Co)authored articles	*H3*	Not supported

of factors outside the model. On the other hand, a rejection of *H2* and *H3* suggests low productivity of academia with regard to outcome indicators.

The low scholarly productivity of academia in the developing countries particularly is attributed mainly to the following:

- heavy workload (teaching and supervisory) due to increasing student enrollments that are not matched by a commensurate expansion of faculty (Tettey, 2008, 2010); and
- unconducive work and/or research environment, limited collaborative efforts – particularly in the art disciplines – and lack of leadership (Mugimu *et al.*, 2009).

Further, graduate studies (Masters and PhD) are in many developing countries characterized by late ages at commencement, low completion rates and lengthy completion time (Tettey, 2008; Mugimu *et al.*, 2009; Wamala *et al.*, 2011). At completion of studies, the graduates are likely to engage more in consultancy work than in scholarly productivity that does not directly provide a solution to the low salaries obtained from academic institutions in these countries. The situation is worsened by the limited funding for scholarly work among institutions in these countries (Tettey, 2008; Mugimu *et al.*, 2009). The staffing shortfall of academia in many developing countries demonstrates a large gap in their human resource capacity. The deficit points to a low ability of the existing academic staff to carry-out research and teaching responsibilities (Tettey, 2010). Thus, individual factors, work environment and institutional factors (Bland *et al.*, 2006; Fabel *et al.*, 2008; Jung, 2012) will have an impact on the associations established in the system. In affirming the role of all stakeholders in enhancing productivity, Bland *et al.* (2006) writes: "a supportive environment facilitates productivity when its features are attended to by leadership and made available to well-prepared faculty".

A direct linkage in the results between the number of students supervised to completion and (co)authored articles supports the argument that high ratio of graduate workload positively impacts research productivity (Jung, 2012). The idea is that students and faculty are able to co-publish their findings. However, it is questionable whether the relationship between outcome and output measures of productivity will have statistical support in academic environments where student enrollments are not matched by appropriate staffing levels. As many academic institutions in Africa are under-staffed (Tettey, 2008), it would not be surprising that academia in the region is characterized by low levels of scholarly productivity (UNESCO, 2010; Yonge *et al.*, 2005; Muula, 2007; Jonathan *et al.*, 2010; Wamala and Ssembatya, 2013).

In conclusion, the findings demonstrate that productivity in output measures can be adopted as a basis for directly or indirectly explaining productivity of academia with regard to the outcome measures. The causal linkages between the indicators of productivity are an indication of the level of research activity of academia. However, the study does not provide an exhaustive assessment of all indicators of productivity in academia. In other words, the study is limited in providing an explanation to productivity with regard to conference papers co-authored, conference chairing, international review committee work, editorships and keynote invitations. Furthermore, the study does not ascertain the quality of productivity indicators assessed. Thus, research into these aspects is required to provide a more

detailed understanding of casual relationships between the indicators of productivity in academia. Nevertheless, maintaining optimal productivity of academia requires that output measures be promoted along-side the outcome measures. Promoting productivity of the latter measures requires collaborative efforts between students and faculty as well as the academic units and/or institutions.

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