

Research governance and scientific knowledge production in The Gambia

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Public research institutions and scientists are principal actors in the production and transfer of scientific knowledge, technologies and innovations for application in industry as well for social and economic development. Based on the relevance of science and technology actors, the aim of this study was to identify and explain factors in research governance that influence scientific knowledge production and to contribute to empirical discussions on the impact levels of different governance models and structures. These discussions appear limited and mixed in the literature, although still are ongoing. No previous study has examined the possible contribution of the scientific committee model of research governance to scientific performance at the individual level of the scientist. In this context, this study contributes to these discussions, firstly, by suggesting that scientific committee structures with significant research steering autonomy could contribute not only directly to scientific output but also indirectly through moderating effects on research practices. Secondly, it is argued that autonomous scientific committee structures tend to play a better steering role than do management-centric models and structures of research governance.

Introduction

Scientific knowledge production, technology and innovation all contribute immensely to a nation's technology-based economy. Public research institutions and scientists are principal actors in the production and transfer of scientific knowledge, technologies and innovations for application in industry as well for social and economic development. The aim of this study was to identify and explain factors in research governance that influence scientific knowledge production and to generate knowledge, which could inform public science and research policy particularly in The Gambia. However, empirical discussions on the impact levels of different governance models and structures are inconclusive in the literature. There are implicit doubts regarding the benefits of both internal hierarchical self-control/management-centric structures and academic self-management (which measures the degree to which research chairs can decide autonomously). Although the benefits or positive impacts of management-centric governance models and structures are sometimes doubted 'because it is argued that research is not a routine task and the most empowering setting is that of academic freedom'¹, it also has not been shown that the scientific committee model actually positively influences research output. Schubert identified and discussed these governance models and suggested that strengthening internal hierarchy (i.e. increasing management grip on research and decision competences of Deans and Chancellors/Presidents of research institutions) contributes positively to research efficiency. In The Gambia, research and science appear to be in a rudimentary state of development and there is no clearly articulated state science and technology policy. According to a report by the Educational Research Network for West and Central Africa², The Gambia evidently lacks capacity for research. The country possesses limited science and technology infrastructure and resources and no proper incentives and partnerships with the private sector (which in itself is underdeveloped) to engage in a more strategic and long-term development of the human resource base. The Gambia further makes very little investment in research and development,³ and primary data are unavailable for concrete policy decisions. A number of authors^{4,5} have argued that factors hindering scientific knowledge production in The Gambia, as in most other developing countries, include lack of legal and strategic frameworks for research and credible governance structures for research. Other factors are a lack of coordination of research activities; inadequate participation of stakeholders in research, policy and implementation processes; lack of demand for research; low accessibility and use of research findings; and inadequate financial and human capacity. However, no empirical work appears to have focused on the effects of research governance factors on scientific performance in The Gambia.

The focus of this study, however, is on the contributions of governance models to research effectiveness defined in terms of quantity of scientific production, not necessarily efficiency. Further, in addressing the lingering question in the literature – that is, what are the impacts or benefits of different governance models and structures in terms of scientific performance/output of scientists – this study identified the scientific committee model of research governance and examined its contribution to knowledge production. In doing so, an attempt was made to identify and explain individual and organisational determinants that influence the research process at the individual level of the scientist, similarly to Horta and Lacy⁶. This postmodern, mixed-methods study was structured in two phases. The first, qualitative, phase, which was a grounded theory study, was used to discover from the participants their own perspectives on those factors or variables that contribute to scientific knowledge production. In the second – quantitative – phase, a positivist approach was used to test hypotheses developed around themes and issues considered important to the research experiences of participants. However, a search for a singular solution later resulted in the integration of the findings from both phases at the point of interpretation and discussion of results.

Methodology

The overall approach to the study was a postmodern, mixed-methods approach, which is a sequential exploratory strategy⁷ involving a combination of qualitative analyses in the first phase (Study 1) and a quantitative analysis in the second phase (Study 2). Specifically, the ontological position of Study 1 is essentially constructionist, its focus exploratory, descriptive and interpretative of the varied and complex research experiences of participants.

Consequently, the design of the qualitative phase is emergent in order to discover meanings as revealed by informants. Further, Study 1 takes the epistemological position of the constructionist paradigm assuming that data are contained within the perspectives of participants involved in scientific search processes as individual researchers, research teams, research governors/managers and research policymakers. Thus, the method for qualitative data collection and analysis is grounded theory, which is appropriate for describing and interpreting research routines and processes under study. As the study objective was also to generate new knowledge to inform public research policy in The Gambia, grounded theory methodology was an appropriate and effective strategy for theory building, which is a crucial basic step in an unexplored area.⁸ Glaser's classic version of grounded theory was used, based on its focus on the emergent nature of theory grounded on data, to select and remain consistent in the application of one approach, thereby avoiding 'methodological muddling'.^{9,10} In providing an explanation for the selection of Glaser's version of grounded theory,¹¹ this approach enabled the inquiry to provide a fresh slant on existing knowledge about public science policy implications for production of scientific knowledge in The Gambia. However, the overall knowledge claim of the study is pragmatic, which means that the investigation is result or problem oriented. The study design is therefore both qualitative and quantitative in thrust, and the overall strategy of inquiry involved the sequential collection of data in order to best describe, interpret and explain the research problem (see Figure 1, which represents the study plan indicating stages of development of the study). By approaching the phenomena under investigation in different ways, from different perspectives, the triangulation of data was possible. Triangulation therefore produced data which otherwise could not have been easily obtained from one source alone.

Research methods and data design

The study area is The Gambia public research system consisting of public research institutions. Data were collected and subsequently analysed from The University of The Gambia, the Educational Research Network for West and Central Africa (both of which are engaged in basic research), the National Agricultural Research Institute, Medical Research Council, The Gambia Unit and the International Trypanotolerant Centre, which focuses on science and technology activities. The Ministry of

Health Units (Malaria and Reproductive Health Units) and the Department of State for Higher Education, Research, Science and Technology, the key player in the research policy arena, were further study points. The need to enhance understanding of a variety of contextual factors that affect research practices and scientific output informed the choice of the study area. The strategies and tactics that individual 'researchers'/actors and the organisations as a whole apply in order to handle the complex organisational processes were also relevant considerations. The study area further permitted in-depth examination of the significance of collaborative research exchanges and their implications for public sector research. In addition, the ease of access to research colleagues who readily responded to the study questionnaires provided further justifications for the selection of the study area. The research design (Figure 1) outlines the use of postmodern, mixed-methods research involving both qualitative and quantitative methods.

The sequential exploratory mixed-methods⁷ began with a qualitative and inductive phase and ended with a quantitative and deductive phase. The deductive part of the research was designed to explain and expand findings from the qualitative phase. Primary data for both phases of the study came mainly from survey questionnaires (structured), semi-structured interviews, three focus group discussions, interview protocols and personal observations. Secondary data were obtained from already published works on research policy as well as institutional data from research institutions in The Gambia.

In the quantitative study, structured survey questionnaires were developed around the initial predictor variables labelled research governance models (i.e. management-centric and scientific committee models of research governance). Scientific committee models anchor on professional self-steering of research by research chairs and scientific committees at different hierarchical levels with a significant degree of autonomy to decide on key research issues. There is limited control over research by the state, external stakeholders and management as well as limited state and research-chair holder competences. Although professionals have critical competence in research, they also play a supportive role in achieving the institutional strategic research agenda. The research chair at the apex hierarchy may deal mainly with strategic research issues by providing the necessary institutional research leadership and coordination of research activities. The explanatory variables emerged from the participants' point of view as the first qualitative phase

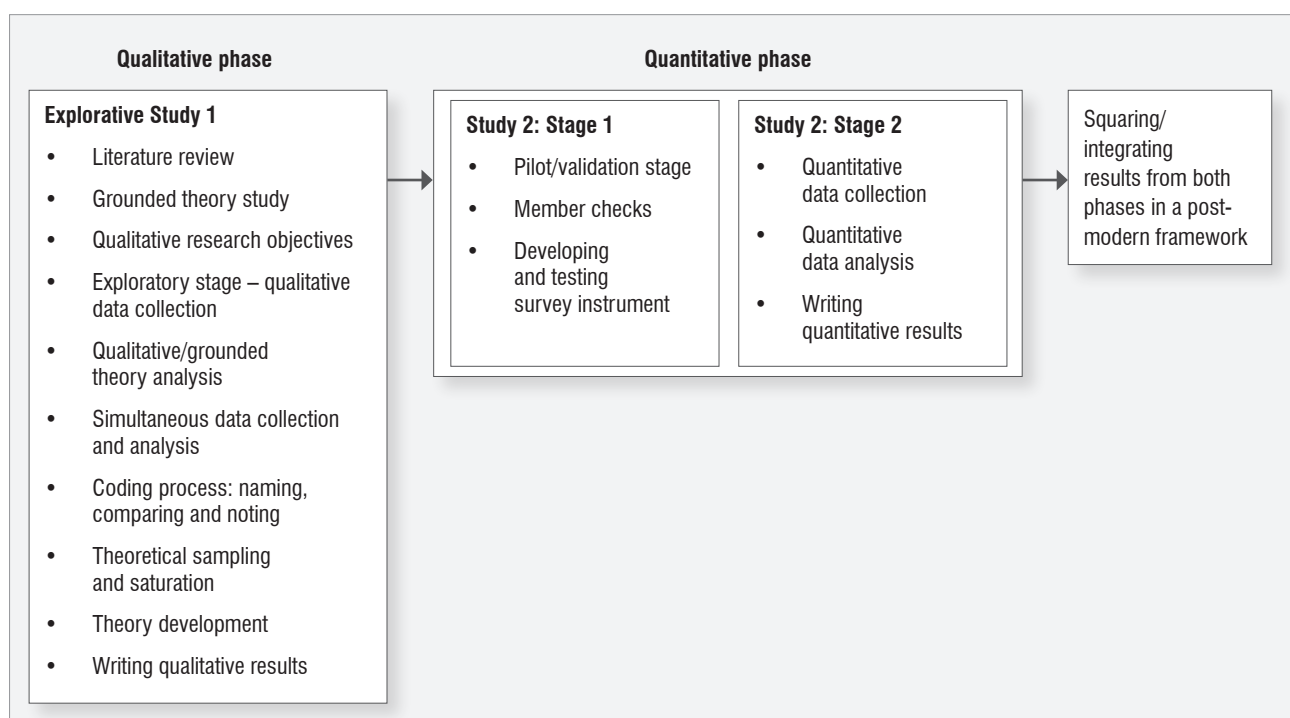


Figure 1: Research design: stages of development.

progressed. The dependent variable was scientific performance/output, which had specific variable indicators and was measured in terms of the number of scientific publications (or articles in peer-reviewed journals), editorships in journals and book series, conferred doctoral degrees (or successful PhD dissertations), research prizes/awards and advisory services to companies/consultancies. A relevant staff list of all public research organisations in The Gambia (including the University of The Gambia) constituted the quantitative study population. The quantitative phase set the sample size at 650 drawn from seven stratified sampling frames obtained from updated computerised files maintained by the University of The Gambia administration and those of the other public research organisations in The Gambia. Table 1 shows the percentage distribution of classes and the sample size.

Table 1: Percentage distribution of classes and sample size

Sample class	Study sample	Population sampling elements (no. in class sampling frame)	% of population
The University of The Gambia	135	250	20.8
Medical Research Council, The Gambia	100	185	15.4
National Agricultural Research Institute	119	220	18.3
Ministry of Health Units (Malaria, Reproductive Health, etc.)	86	160	13.3
The International Trypanotolerance Centre, The Gambia	76	140	11.7
The Educational Research Network for West and Central Africa	109	200	16.7
The Department of State for Higher Education, Research, Science and Technology	25	45	3.8
Total	650	1200	100%

The quantitative survey adopted both non-probability (convenience sampling) and random systematic sampling techniques. However, the data collection procedure in respect of Study 1 involved joint systematic data collection, coding, and analysis with theoretical sampling to develop a grounded theory of scientific knowledge production. The process involved coding and summarising data, reassembling emerging variables and making propositions about them, and, through a selective coding process (by which core variables are identified), establishing the basis for formal theory. On the other hand, quantitative data collection and analysis involved the use of simple statistical tools (frequency distributions, means or modes, standard deviation/standard error of a sampling distribution, percentage tables and a five-point Likert scale) to test hypotheses developed around themes and issues considered important to research experiences of participants. Integration of research findings from both phases of the study occurred at the point of interpretation/discussions of results in a postmodern framework to produce deeper insights and a more comprehensive analysis of public research phenomenon in The Gambia.

Qualitative and quantitative data analysis

The mixed-methods strategy for data collection and analysis was sequential exploratory,^{7,12} meaning that qualitative data collection and analysis was undertaken first, followed by collection and analysis of

quantitative data. Both phases were given equal priority or weight in the process. Integration of qualitative and quantitative data and findings, which occurred at the point of data interpretation and discussion of results, involved comparing and collating data and findings from the qualitative phase with data, findings and conclusions from the quantitative phase. This strategy enabled the exploration of not only the phenomenon under study, but also the elaboration and clarification of the qualitative results with results from the quantitative method.^{7,12,13} It became possible to test some elements of the emerging theory of scientific knowledge production from the qualitative phase and generalise results to the study population.

Describing qualitative results

Based on Glaser's version of grounded theory method¹⁴, the following techniques for concept coding were employed: (1) open, axial and selective coding of key themes; (2) writing memos for every interview summarising key themes; and (3) recording a 'researcher's journal' that puts together key concepts across all the interview protocols. Each data set was separately open coded when collected, and data collection continued until saturation was achieved by the 15th interview. Axial and selective coding were performed after open coding. Axial coding consisted of relating categories to one another and transforming the initial categories to their subcategories (Table 2). Selective coding permitted the identification of conceptual ideas that integrated the existing categories by making relational statements using memos created during the continuous process of data collection and analysis. As categories, which emerged and evolved during data collection, became structured and saturated, relationships between categories were examined by means of systematic comparison. Memos created as the research progressed directed the creation of a 'researcher's journal', in which all key concepts were listed and relational statements between concepts formed during axial coding were indicated. Codes collapsed these memos as they began to resemble each other during organisation and memo sorting. Consistent with the rigor of implementing methodological procedures of grounded theory, discipline in the methodology and the need to properly explain the process by which the theory was generated,^{10,15} a resultant theory of knowledge production emerged as categories became saturated and concepts and relational statements connecting them became fully defined and clarified.

All the reported qualitative results were derived inductively from qualitative data, which were generated from semi-structured interviews, focus group discussions and two interview protocols. By undertaking a grounded theory approach, it was found that research practices and behaviour not only impact on the scientific output of the scientist but are also a function of governance categories. For the purpose of this study, the term 'research practice' is used to describe how scientists organise their work, the structure of their research process, and the 'doing of' research. It is about the scientist's decisions regarding research topics, priorities and agendas. It is also about research funding decisions, decisions on how much time is devoted for teaching and research (in respect of academics), decisions about research output orientation in terms of quality versus quantity, publication strategy and collaborative research efforts.¹⁶ Research practice is about all the research-related decisions and behaviours of the scientist. The expectations of scientific committees, demands from professional competitions, recognition among peers, and pressures arising from peer evaluations affect these decisions and behaviours. Through similar mediating influences by means of institutional research policies, the management-centric governance category impacts on research practices. Funding decisions of scientists remained largely constrained, and choices and decisions about research interests and priorities depended on limited funding options in a stifling research context defined by state and institutional policies. Participant 13 limited his research to 'things I can fund myself...so the areas I am hoping to work on, or areas I am not working on are basically things I feel that I can't fund by myself'.

On the other hand, by means of intervening conditions defined by the expectations of peer evaluators for quality, ethical standards, procedural norms and values of scientific research, the scientific

Table 2: Axial coding sheet

Phenomenon	Scientific committee governance	Management-centred governance
Causal conditions	Significant autonomy over research issues by scientific committees; state and institutional research policy; external stakeholder factors	Dominant control over research by institutional management; state and institutional research policy; external stakeholder factors
Context	Autonomy for researchers and supportive feedback from research governors/scientific committees	Overbearing management; some support from professionals and scientific committees; often stifling research situation
Intervening conditions	Mediating influences of procedural values, norms and rules; professional ethics (regulating scientific enterprise) on research practices/behaviours	Defining factors of state and institutional science and research policies
Action/interaction	Conduct of research; interaction with scientific committees; wide and extensive collaborations and networks	Conduct of research; interaction with management and external stakeholders; very limited internal research collaborations
Consequences/inferences	Better positioned than other governance models and structures to impact on research practices and scientific performance	Could positively contribute to effective scientific performance provided supported by scientific teams

committee category impacts on research practices, such as deciding how much time to spend on research, and how to structure the work. Participant 3 thought that 'quality has to be given high priority in organising your research'. Most respondents preferred to publish their work in foreign scientific journals, and, because of limited publication options available, they believed that this publication strategy encouraged them to focus on the quality of the work. Participant 13 thought that by focusing on quality, there is a focus on doing it [research work] rightly to be accepted for publication'. Offshore publication, and thus publication behaviour, exposed respondents to foreign professional research expertise, which shaped their overall research behaviour and consequently positively influenced the quality of their research. In brief, the qualitative study inductively established that the scientific committee category impacts on research practices by means of support for quality of research, peer-based evaluations and supportive feedbacks as well as fostering professional competition for recognition among peers and collaborative exchanges. Participant 1 thought that 'publishing encourages competition...and publishing offshore...ensures that your work meets international standards or quality'. Participant 2 added 'you go for foreign journals so that the more of these you publish the more recognised the researcher becomes'. Apparently, the scientist learns through doing and exposure to the expertise of 'other professional colleagues'. Thus far, the description of results underpins the process of theoretical integration, and, drawing from Glaser's^{17,18} ideas on theoretical coding during the advanced coding stage, as well as employing existing theories, it is inductively evident that a fluid interface between the scientist and scientific committee governance structures is a necessary condition for improving research practices and behaviour and scientific performance. Through support provided by professional colleagues in terms of opportunities for collaborative networking and supportive feedbacks, and through doing, exposure and experience were enhanced and research practices and behaviour improved. The scientific committee category thus impacts on communication behaviour and other research-related behaviours of scientists. Qualitative evidence shows that, although limited research is currently taking place in The Gambia and public and private sectors, linkages and support for research are still expanding; institutional science policy nevertheless encourages collaboration, particularly external exchanges. Apparently, external networks and contacts with external educational and scientific institutions are growing rapidly. Qualitative evidence further indicates a high degree of preference among academics and scientists to interact with colleagues from external universities and research organisations. There is also evidence of internal co-authorship networks. Publication data and information obtained from institutional databases show that all publications by respondents interviewed were 'offshore', that is, papers were published in international scientific journals. In this context, most informants agreed that collaborative exchanges 'enhanced human capacity' and produced 'quality [research] and added value'. Collaborative research exchanges positively affected the 'capacity' of the

scientist to conduct research. Participant 7 believed that collaboration with international research institutions can 'give you insight into other research activities that are taking place elsewhere in the world' and can also help to 'build relationships between researchers in the international arena'. Participant 5 stated that collaboration expanded the scope of his research interests. Participant 13, a medical scientist, added:

...those kind of collaborations, whether with funders, industry, or even among colleagues, you know... brings out the best in research because definitely surgeons have an expertise in certain areas and if we have people who are good statisticians for example, we would have made excellent combination to collaborate with such kind of people [sic].

Moreover, Participant 10 thought that 'collaborative research reduced costs and time [spent on research]', expanded funding sources and provided opportunities for dissemination of research results. Collaborative research exchanges defined how scientists organised their work. These exchanges or collaborations are also about decisions to link up with colleagues, and share and benefit from the resources and expertise of others involved in research. Thus, collaborative research exchanges are categorised as communication behaviour, which is one of several research-related behaviours.

Theory of scientific knowledge production

Theoretical integration of these concepts led to the following theoretical postulations. Firstly, a fluid interface between the scientist and scientific committee governance structures is a necessary condition for improving research practices and scientific performance. Research practice, through experience, becomes productive as scientists deepen their professional interaction with colleagues. In addition, the steering of research by scientific committees is not only a prerequisite for productive research practices, but also enhances research competences. In this context, the analysis of qualitative data inductively established that the scientific committee category impacts on research practices by means of support for quality of research, peer-based evaluations and supportive feedbacks as well as by fostering professional competition for recognition among peers and collaborative exchanges. Hence, research practice/behaviour is a function of governance categories. Secondly, scientific committee structures with significant research steering autonomy tend to be better at steering roles than management-centric models and structures of research governance. Further, management-centred governance structures are characterised by tight control and coordination of research processes; overbearing and unchallenging, non-competitive

and de-motivating research environments impair scientific performance. In brief, key findings from this phase are:

1. Research practices/behaviour is a function of governance categories, and influences the scientific output of the scientist.
2. By means of intervening conditions defined by the expectations of peer evaluators for quality, ethical standards, procedural norms and values of scientific research as well as fostering professional competition for recognition among peers and collaborative exchanges, the scientific committee category impacts on research practices.
3. A fluid interface between the scientist and scientific committee governance structures is a necessary condition for improving research practices and scientific performance.
4. Scientific committee structures with significant research steering autonomy tend to be better at steering roles than management-centric models and structures.
5. Management-centric structures characterised by tight management control and coordination of research process, and overbearing, unchallenging, non-competitive and de-motivating research environments impair scientific performance.

A validation stage preceded the quantitative data collection and analysis in order to ensure that relevant survey questions were asked and directed towards the quantitative research objectives and to enhance the validity of the findings. Validation measures consisted of a member check, development of a survey instrument based on specific themes and views of respondents in the qualitative phase for generating quantitative data, pre-test of the survey instrument, and triangulation of data sources.

Quantitative data analysis involved testing the relationships among scientific committee governance structures, management-centric structures and scientific performance. The analysis further involved the use of descriptive and inferential statistics, employing the chi-squared technique in testing the following hypotheses:

- Hypothesis 1 – the effect of scientific committee structures and management-centric structures on research output/scientific performance is insignificant.
- Hypothesis 2 – the effect of scientific committee structures and management-centric structures on research output/scientific performance is significant.

Summary of key quantitative findings

Two governance categories – scientific committee structures and management-centric structures – were used in a Likert-type scale to

measure and analyse the degree of their impact on research output or scientific performance defined in terms of the number of published scientific works, conference papers, and supervision of graduate theses. The quantitative responses to a five-point itemised rating are shown in Table 3. A total of 15 respondents strongly agreed and 45 agreed that scientific committee structures enhanced scientific performance; this finding is further supported by the mean score of 3.62 on the Likert scale (Table 3). Table 4 summarises the sample means. The measure of dispersion of responses used was the standard deviation. The lowest standard deviation (0.94) was for scientific committee structures, which showed that respondents did not differ much in their responses in respect of these factors. The highest standard deviation (1.10) was for management-centric structures, indicating that respondents varied in their responses towards these factors. However, about 84 of the respondents agreed and 254 disagreed (while 141 strongly disagreed) that management-centric structures enhanced research performance (Table 3). This result (a mean score of 2.56, i.e. less than 3, on the Likert scale) therefore indicates that management-centred research steering structures do not support scientific performance. From all indications, the results of analysis of the quantitative data show that scientific committee structures positively influenced research output (scientific performance). Overall, key quantitative findings are:

1. A management-centric structure of research governance limits scientific performance.
2. A significant correlation exists between research output or scientific performance (as a dependent variable) and scientific committee structures (as a predictor).

Discussion

The major contributions of the study to the ongoing, although limited and mixed, empirical discussions in the literature concerning the benefits and impact levels of different governance models, will be elaborated on. The analysis fills a gap in the literature by addressing the complex intervening and moderating influence of governance structures on research behaviour and practices of researchers and their scientific output. The multidimensional nature of research-related behaviours and their mediated contribution to scientific performance also are discussed.

Conclusion 1: Management-centric models and structures of research governance can positively contribute to scientific performance, provided they are supported by advisory groups of mainstream scientists or academics at key hierarchical levels of governance.

Table 3: Influence of governance structures

Governance structure	X	Frequency	Cumulative frequency	Mean	Standard deviation	%
Scientific committee structures	5	97	485			15
	4	292	1168			45
	3	195	585	3.62	0.94	30
	2	48	96			7
	1	16	16			3
Management-centric structures	5	28	140			4
	4	84	336			13
	3	254	762	2.56	1.10	39
	2	141	282			22
	1	141	141			22

Response levels of agreement on predictor impact on scientific performance: 1, no view; 2, strongly disagree; 3, disagree; 4, agree; 5, strongly agree.

Table 4: Summary of means

Predictors/explanatory variables	N	Mean	Standard deviation	Minimum	Maximum
Scientific committee structures	648	3.62	0.94	1	5
Management-centred structures	648	2.56	1.10	1	5

Scientific committee structures with significant research steering autonomy tend to be better at steering roles than management-centric model structures. With appropriate competences and steering autonomy, scientific committees could take and implement more informed research decisions than institutional management or even research chairs who, when acting alone, may either ignore or overrule professional advice and inputs.

A common finding from both phases of the study was that the scientific committee model of research governance positively influenced scientific performance across research institutions in The Gambia. A mean score of 3.62 (close to 4) on the impact of scientific committee structures indicates a significant effect. A majority of respondents in the qualitative study believed that effective research performance was possible if scientists and academics and their professional committees played a significant role in steering research. However, the findings of this study indicate that management-centric structures could in fact inhibit performance where overbearing management-controlled research structures create unchallenging research environments. From the quantitative analysis of data, the mean score of 2.56 (below 3) on the impact of management-centred structures indicates an insignificant effect. These results suggest that, across research institutions in The Gambia, the insignificant contributions of management-centric models and structures of research governance to scientific performance were a result of ineffective management systems, poor management of staff and resources and non-inclusion of inputs and support from mainstream scholars. Management ineptitude and non-prioritisation of research, ineffective research governance structures and weak coordination of research activities are other plausible explanations for the insignificant contribution of management-centric governance structures, which is corroborated by earlier reports.^{4,5} Another contributing factor could be very limited investment in research and development in The Gambia.³ Overall, it is not surprising that, under these conditions, management-centric structures of governance limited scientific output. Nonetheless, this finding does not suggest that management-centred structures of research governance do not produce important research outputs. On the contrary, Schubert¹ found positive impacts on research steering by management authorities. According to the European Commission¹⁹, executive leadership in research governance could promote higher quality education and more relevant research output, if a number of hierarchical levels of research decision competences are in place and external stakeholders provide a supportive role in driving research. These hierarchical structures and support from scientific teams are found at the University of Melbourne, where there are several levels of research hierarchies with the Deputy Vice Chancellor (Research) at the apex providing academic leadership in research and delivery of the university's research agenda. The Pro Vice Chancellor (Research Collaboration) and Pro Vice Chancellor (Graduate Research) support the Pro Vice Chancellor (Research) who is responsible for research performance and research ethics and integrity. At the faculty level, Associate Deans (Research) provide 'local' leadership in research planning, target setting, research development and performance review. Heads of academic departments provide important leadership in research and research training. Most faculties have faculty research managers to manage the administration of research activities within the faculty. Two committees report directly to the Deputy Vice Chancellor (Research): an advisory group of senior academics that provides advice on strategic issues such as research investments and priorities and the committee of associate deans that provides advice on research policy and operational matters. There are a number of other research sub-committees which report through the committee of associate deans, and which are concerned with policy development and review as well as engagement with external regulators.²⁰ An important feature

of these management-centric structures is the conspicuous presence of research managers and a hierarchy of managers and the absence of scientific committees with significant research steering autonomy. Management-centric structures do not have scientific committees with fully fledged research competences in the management of research activities as well as competences for the determination of research investment, policy development, research ethics and peer review. Rather, every other point in these hierarchies ultimately reports to the Deputy Vice Chancellor (Research) while the scientific and technical advisory committees play only professional advisory roles.

In contrast to the situation at University of Melbourne, the management-centric governance structures in the particular context of public research institutions in The Gambia appear to be highly centralised. At the same time, support from scientific committees is very limited. Research policy development, research investment and funding, and other critical research issues including research collaboration and partnerships, research initiatives and intellectual property management, if any, are determined and treated as administrative matters without significant input from scientists. The University of The Gambia had a Research and Strategic Committee, consisting of professionals/scientists, which steered research until 2009. From 1999 to 2009, the University of The Gambia produced significant research outputs. However, this committee, as well as other sub-departmental or faculty scientific committees, seem to have become either redundant or moribund. In the National Agricultural Research Institute, the Director General, Deputy Director General and the Director of Research manage research. Scientific committee structures with significant research competences appear to have disappeared within the same period in the Institute. In this context, a majority of respondents in the qualitative survey of data commented that:

We do not have these committees [or] evaluation committee[s] within the research system. Scientists are left to coordinate among themselves and decide what things to work on in a particular season, you know, and then they later come to management to make a final decision.

Respondents also agreed that 'it is only management that dictates what one does and when' and 'if...you are not in the good books of management...they would not want to fund your activity'. It is thus understandable why, in this context, management-centric governance structures of research governance, without supportive research steering roles from scientific committees, actually inhibited research output. This finding therefore suggests that management-centred governance structures have not created 'that atmosphere for competition' because 'in having good research there must be an atmosphere of competition'. Because scientific committees do not exist, management 'does not mind much, if problems arise...they do not even scrutinise the outcome of some of the research that the scientists have produced'. Overall, these findings suggest that scientific committee models and structures of research governance tend to be in a better structural position than management-centric models and structures to steer research and handle critical research issues of peer review and governance of behaviours of researchers. A plausible explanation is that scientific committees with significant autonomy could create a more enabling and challenging research environment; better foster research collaborations and exchange of information among colleagues; understand and resolve critical research issues; and make and implement more informed research decisions than institutional management. The key strength of scientific committee structures appears to lie in consultation and consideration of a wider range of options in decision-making and implementation, as inputs could come from core scientists across

hierarchical levels of the structure. Another plausible explanation for the better performance in a steering role by scientific committee structures derives from traditional peer-based evaluation of the work of scientists and scholars. Research steering scientific committees may be more inclined to accept reforms such as those suggested by Osterloh and Frey²¹ in favour of a combination of qualitative peer reviews and bibliometrics, which can balance the advantages and disadvantages of the two methods in measuring the scientists' performance²²⁻²⁵. While bibliometric indicators provide extrinsic incentives for performance, and qualitative reviews, anchored on quality, provide intrinsic motivation, the combination of the two methods could possibly improve rankings as instruments for monitoring and sanctioning, or precisely, governing the behaviour of scientists. The preference for autonomy in choosing one's own goals is important for innovative research, because it guarantees useful self-selection effects and is the most important prerequisite for intrinsic motivation.²⁶⁻²⁸ Hence an approach which combines both qualitative peer review and bibliometrics would generally improve the governance system and allow more room for creative research to blossom. Consequently, within the context of this study, the argument is that scientific committees consisting of mainstream scholars and scientists who understand the process and content of research would more readily introduce qualitative peer evaluations (or better still, a combination of quality- and quantity-based evaluations), foster creative research and generally improve the governance system. However, there might be limitations to realising these advantages because of pressures that could arise from expectations of peers, which include biases based on views contradicting those of the mainstream scholars. Another obstacle could be discouragement among scholars from conducting and submitting creative and unorthodox research.^{29,30}

Conclusion 2: *Scientific committees could mould and sustain appropriate research behaviour and practices and competences of individual researchers and research teams by fostering linkages, effective communication, and institutional socialisation and by means of peer review.*

Turning to the finding that a connection exists between research practices and behaviour and scientific committee models and structures, results from analysis of data suggest that autonomous scientific committee structures exert a moderating effect on research practices, and, for this reason, can improve the research competence of individual scientists. This moderating influence of scientific committee structures on research behaviour appears to account to some extent for the nature of interconnectedness of some of the multicausal factors of knowledge production.

After a detailed examination of the qualitative evidence, it can be reasonably asserted that, in the context of institutional research, scientific committee structures of research governance have greater impetus to encourage and enhance collaborative exchanges, foster important research expertise and behaviours and ultimately improve scientists' performance effectiveness. As deductively derived from data, the connection (or interaction) between research practices and scientific committee structures implies that these structures support the doing of research. For this reason, scientific committee models and structures of research governance could be a necessary condition for productive research practices. The argument is that the association between research practices and behaviour and effective research performance tends to be strong (or otherwise weak), depending on other conditions or factors, such as varying 'values/weights' of scientific committee structures. This implies that the effect of research behaviours on scientific performance would increase (or otherwise decrease) depending on varying levels of autonomy in steering research by scientific committees. The effect of this association changes in intensity or direction when these conditions occur, i.e. when there are variations in the value or weight of scientific committee structures. It further implies that different levels of, or changes in, decision-making competences of scientific committee structures could produce corresponding changes in the association between research practices and scientific performance. The following explanations seem reasonable.

Firstly, an important observation is that none of the previous empirical studies, including that of Schubert¹ which focused on impacts of different governance models and structures, have tested the contribution of the influence of scientific committee models and structures on scientific output. This governance model consists of research chairs and scientific committees holding autonomous decision competences. Rather, Schubert¹ found that the influence of deans and chancellors and presidents of research institutions had a positive impact on research efficiency (provided that they used their power and influence wisely). Schubert was concerned with linking relationships between inputs and outputs to governance structures in terms of efficiency, which is calculated using a field-specific differences estimator (FDH). The FDH procedure constructs an estimated frontier out of a sample of observed units, where FDH is an estimation of a production frontier, which is defined as the maximum output producible at a given input level. In this context, Schubert examined the association between new public management governance mechanisms and efficiency. In contrast, in this study, the mediating effects of autonomous scientific committee structures on research practices were examined and outcomes of research were determined using publication counts (number of scientific publications and citations) as a proxy for scientific performance (i.e. output effectiveness). Publication counts were used because comparisons were not made across research institutions, so as not to disadvantage research institutions that specialise in activities measured by other output indicators. Hence, it is argued that, in the context of institutional research, scientific committee models and structures of research governance, more than most other governance models and structures, create a more enabling and challenging research environment. In this model, described as professional self-steering, research chairs and scientific committees at different hierarchical levels could have a significant degree of autonomy to decide on key research issues. However, within the framework of institutional mission and science policy, internal guidelines and inter-institutional agreements, the research chair in the apex hierarchy could deal mainly with strategic research issues, providing the necessary institutional research leadership and coordination of research activities. Departmental scientific committees and research sections could provide support on research direction and priorities and sectoral research leadership. In brief, unlike the governance pattern often described as new public management³¹⁻³³, the scientific committee model anchors on limited control by the state, external stakeholders and management, as well as limited state and research-chair holder competences. However, the model still maintains the spirit of new public management as it gives greater steering autonomy to researchers and research teams. Thus, given these critical competences over research, and in playing a supportive role in achieving the institutional strategic research agenda, scientific committee governance structures could mould research behaviours at the level of the individual scientist by facilitating both internal and external research collaborations, shaping not only individual research behaviour and practices but also possibly the entire institutional research process. When not distracted by exigencies of institutional management and administration, and concerned primarily with research and research-related activities (e.g. teaching, research supervision and mentoring), research leaders speak the language of peers and understand their concerns. It would thus appear that they are in a better position to understand and resolve critical research issues of governance, professional information, research management and administration, grant conditions of awards and research-related contracts, contacts with relevant stakeholders, and opportunities, responsibilities, risks and benefits associated with collaborative initiatives. With appropriate competences and steering autonomy, scientific committees could take and implement more informed research decisions than institutional management or even research chairs who, when acting alone, could either ignore or overrule professional advice and inputs. For these reasons, it is argued that scientific committee structures of research governance, more so than other governance structures, could better facilitate the establishment of information exchange networks that enable researchers to make important choices concerning research topics and priorities, funding sources, publication orientation and strategies as well as communication options. This is because the information exchange networks which define

scientists' communication behaviour, tend to maximise resources, find complementary skills and expand the organisation's ability to generate and access new knowledge.^{34,35} In addition to providing professional research services – which might include promoting the preparation of high-quality proposals and information to researchers on research integrity and ethics by means of guidelines, individual assistance, websites, training and workshops – scientific committees could enable scientists to improve their research and their competences. In support of this view, Osterloh and Frey²¹ argued that a governance system based on qualitative evaluation of peers and supportive feedback would be able to inform researchers on how to improve their research and their competence. Peer reviews or 'evaluations are reasonable mechanisms to enhance publishing activities'¹, and develop reputations that come from quality publication, in particular creativity.³⁶ Based on these arguments, scientific committees could encourage the development of appropriate publishing behaviour by scientists. In brief, by fostering linkages, effective communication, institutional socialisation, and by means of peer reviews, scientific committees could mould and sustain appropriate research behaviour and practices and competences of individual researchers and research teams. This suggestion is consistent with the assertion that scientific collaboration results in the generation of new knowledge, new method and new approaches.³⁷ However, there may be a technical problem in determining the precise mediating effect of scientific committee structures on research practices because the association is qualitatively determined. There also is a possible danger of using this recipe to create a governance model that can be hijacked by professional oligarchs. A limitation to this study is the lack of crucial data to investigate the precise moderating effects of scientific committee structures on research behaviours of scientists; this could be considered as an area for future research. Nonetheless, the analysis yields the insight that research institutions, considering their missions, should wisely choose their governance system because of the far-reaching implications it might have for the research practices or behaviours of scientists and their knowledge production.

Conclusion

This study contributes to empirical discussions on research governance, showing that scientific committee structures with significant research steering autonomy contribute not only directly to scientific output but also indirectly through moderating effects on research practices and behaviour. By generally contributing positively to the development of appropriate research behaviour, this model and its governance structures could have profound impacts on scientific outputs. Autonomous scientific committees could mould and sustain appropriate research behaviour and practices and competences of individual researchers and research teams by fostering linkages, effective exchange of information among peers and institutional socialisation and by means of qualitative peer-based evaluations. However, it is acknowledged that, if supported by advisory groups of mainstream scientists and academics at key hierarchical levels of governance, management-centric models and structures can positively contribute to scientific output. Overall, as original research, particularly creative research, and innovations require autonomy, individuality and freedom on the part of researchers, research teams and governors of research institutions must set up suitable governance models which provide for significant decision-taking autonomy at key hierarchical levels of governance. A national research council which guides and focuses research activities according to the needs of society and industry could support such suitable governance structures, which are tailored towards the institutional mission.

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