

OPTIMISING GOVERNANCE CAPABILITIES FOR SCIENCE, RESEARCH AND INNOVATION IN AFRICA

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This article discusses empirical challenges and opportunities for African countries in their quest to have sustainable mechanisms for funding research and innovation. Like elsewhere in different parts of the world, African countries have been exploring different approaches, institutional reforms, models and mechanisms towards more efficient and effective funding and financing of research and innovation to enhance their individual and collective economic development aspirations. This paper derives from a 2018 study which used a combination of primary and secondary data sources to inform current debates and reviews on the re-organization of research and innovation funding in Africa. Attempts to copy experiences of high income economies in harnessing and deploying funding mechanisms into national research and innovation systems are not appropriate if not accompanied by adaptation to systemic and contextual aspects in receiving countries and sectors. This paper presents and analyses recent empirical evidence from 15 African countries to argue that successful adaptations are not just a matter of technological and innovation capabilities, timely and adequate resourcing, but are a function of decision-making and governance capabilities, which in turn arise from deliberate and interactive learning across the entire research and innovation system.

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Research Data Related to this Submission

There are no linked research data sets for this submission. The following reason is given:
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- African countries have many economic development challenges and opportunities to deal with
- New knowledge from research and innovation seen as key drivers in these, but these drivers need resources
- Different ways of funding research and innovation have been deployed, but some shortcomings remain, with respect to, inter alia, consistency of the funding, sufficiency of the funding and relevance of the funding - which all affect the impact of the funding and actions funded
- This paper presents and analyses recent empirical evidence from 15 African countries to argue that successful adaptations are not just a matter of timely and adequate resourcing, or technological and innovation capabilities.
- They are a function of decision-making and governance capabilities, which in turn arise from deliberate and interactive learning across entire research and innovation systems.

Optimising governance capabilities for science, research and innovation in Africa

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Abstract

This article discusses empirical challenges and opportunities for African countries in their quest to have sustainable mechanisms for funding research and innovation. Like elsewhere in different parts of the world, African countries have been exploring different approaches, institutional reforms, models and mechanisms towards more efficient and effective funding and financing of research and innovation to enhance their individual and collective economic development aspirations. This paper derives from a 2018 study which used a combination of primary and secondary data sources to inform current debates and reviews on the re-organization of research and innovation funding in Africa. Attempts to copy experiences of high income economies in harnessing and deploying funding mechanisms into national research and innovation systems are not appropriate if not accompanied by adaptation to systemic and contextual aspects in receiving countries and sectors. This paper presents and analyses recent empirical evidence from 15 African countries to argue that successful adaptations are not just a matter of technological and innovation capabilities, timely and adequate resourcing, but are a function of decision-making and governance capabilities, which in turn arise from deliberate and interactive learning across the entire research and innovation system.

Key words: Africa, funding, governance capabilities, innovation, research

1.0 INTRODUCTION

Africa needs to industrialise and achieve rapid economic growth to improve the livelihoods of citizens and attain amongst other imperatives robust infrastructure that supports health, energy, environmental and food security as well as full employment that leverages the demographic dividend highlighted in Agenda 2063. Acknowledging that science, technology and innovation play a significant role in driving economic growth and development through enhanced industrial activities and competitiveness backed by increased production efficiencies (Oyeyinka et al, 2018; Chataway et al., 2009; NACETEM, 2010; NEPAD, 2006), African countries have explicitly committed themselves to raising their domestic research expenditure to at least the equivalent of '1% of their gross domestic product' (Lagos Plan of Action, 1980). However, almost all the countries are failing to fulfil this commitment and calls for increased funding have grown. For health, governments agreed in the Algiers Declaration to allocate 5% of the National Health Budget to health research yet few are meeting this target (Nabyonga et al, 2018). Overall, commitment towards deploying science, technology and innovation (STI) to strengthen economies is not lacking. For example, the AU Agenda 2063, '*The Africa We Want*', aspires for a prosperous Africa imbued with means and resources to drive sustainable development and long-term stewardship of resources, where African people have a high standard of living, quality of life, sound health and well-being (AUC, 2015). More specifically, in order to deliver on Agenda 2063, the Science, Technology and Innovation Strategy for Africa, STISA-2024 was developed, and it identifies research and innovation as enablers for achieving Africa's sustained growth, competitiveness and economic transformation (AUC, 2014). STISA-2024 calls for continuous embedding of STI in six priority areas namely: eradicating hunger and ensuring nutrition and food security; prevention and control of diseases and ensuring wellbeing; communication (physical and intellectual mobility); protecting our space; living together; and wealth creation. A major recognition in STISA-2024 is that the continent needs to apply existing and emerging technologies in order to accelerate Africa's desired transition into an innovation-led, knowledge-based economy.

That the place of science, technology and innovation on the national, regional and continental policy agendas in sub-Saharan Africa (SSA) has become markedly more prominent in recent years is not only reflected through initiatives such as STISA-2024, but also through policy and institutional developments at various levels (UNESCO, 2016). At continental level, the New Partnership for Africa's Development (NEPAD) is now well established institutionally and continues to evolve in its role of implementing African Union policies. Recently transformed into the African Union Development Agency, NEPAD has an Industrialisation, Science, Technology and Innovation Hub with a number of thematic areas¹, including: African Biosafety Network of Expertise (ABNE) Biosciences eastern and central Africa - International Livestock Research Institute (BecA - ILRI) Hub; African Institute for Mathematical Science (AIMS) - Next Einstein Initiative; Bio-Innovate; African Medicines Regulatory Harmonisation (AMRH) programme; NEPAD Water Centres of Excellence; African Science Technology and Innovation Indicators (ASTII) initiative; Southern African Network for Biosciences (SANBio) and Alliance for Accelerating Excellence in Science in Africa (AESA). NEPAD also works alongside other AU science-related arms, such as the Scientific and Technical Research Commission (AU-STRC).

Various surveys on countries having S&T or STI policies show a gradual increase from none

¹ <http://www.nepad.org/rec/industrialisation-science-technology-and-innovation>

between 1960 and 1980, to about 13 out of 17 surveyed by Mouton et al (2014) in 2010, and there is now widespread adoption of STI policies and institutional developments in support of these initiatives at the sub-regional level (UNESCO 2016) and by many SSA countries (AOSTI 2013). These developments are happening in the backdrop of the adoption by the international community of the Sustainable Development Goals (SDGs), which include specific reference to STI within SDG 17 (UNGA 2015). This is in contrast to the absence of explicit reference to STI in the Millennium Development Goals, which some argue may have hampered efforts to pursue STI capacity building (HOC-STC 2012). Accompanying these policy developments has been an increase in the number of donors interested, or active, in supporting STI in Africa compared with the support of just a few during the 1990s (AOSTI 2013).

While more than two-thirds of African countries have moved to design and adopt STI policies and strategies (The African Capacity Building Foundation, 2017), a majority of the countries still lack the requisite capacity to leverage and fully benefit from investment in STI (Oyeyinka et al, 2018). They have not solved the challenge of sustainably funding research and innovation and as a result they are failing to effectively generate and deploy knowledge and technological innovations for socioeconomic growth and societal benefit (ACBF, 2017), by harnessing introduction of new and/or improved products and services in key economic sectors such as agriculture, mining, manufacturing, health, education, communication and infrastructure.

Appropriation of new knowledge generated by contextualised research and innovation is a key driver of sustainable and inclusive socio-economic development. However, research and innovation are resource-intensive, depending to a large extent on sustainable and focused funding buttressed by an innovation ecosystem purposively designed to harness innovations and turn them into useful products and services for society. Many African countries do not yet have these conditions in place. Given the aforementioned, funding of research and innovation in Africa requires new models that take a deliberate systemic approach to building coalitions of agents and actors in innovation systems (national, sectoral, regional and technological), policy and governance design and architecture and funders that support appropriate emerging technologies and innovations. The financing challenge pervades the research-translation-commercialisation spectrum, and in this paper, we look at contributions towards addressing this challenge by science granting councils (SGCs), governments, philanthropies, development agencies, commercial and non-profit actors.

1.1 Aim of this paper

This paper is situated in the backdrop of declining or stagnant national and international research funding sources and the increasing need for new models to fund research and innovation. African countries have an opportunity to avoid technology and development lock-in as well as path dependencies by leapfrogging infrastructure and industry challenges of pioneers through carefully integrating their transition to knowledge-based economies (KBES) with achievement of SDGs and leveraging their endowments in natural resources and an imminent demographic dividend (African Union Roadmap, 2017). This is possible through context-specific and locally grounded generation and utilisation of new knowledge from research and innovation. Funding these endeavours requires designing sectoral and national policies and strategies for investing in local research and innovation, for which scientific, technological, financing and governance capabilities are key components. Focusing

particularly on governance capabilities, this paper is guided by the following key research questions, which were part of a broader study on new approaches for funding research and innovation in Africa:

1. What historical and current factors facilitate or constrain the implementation of new funding approaches and how have/can the gains be enhanced or the challenges resolved?
2. What institutional reforms accompany new funding approaches and how can African countries re-position their own institutional architectures for enhanced research and innovation funding?
3. How are other broader issues pertinent to research and innovation broadly being taken into consideration towards more efficient and effective funding for research and innovation?

In order to gather evidence to address these questions, and as will be explained further in the methodology section, a number of methods were deployed, including literature reviews covering documents from national science councils/commissions and other funding agencies, interviews with representatives from the 15-country African Science Granting Councils Initiative², and interviews with expert stakeholders from institutions supporting or implementing research in Africa, as well as scholars, policy makers and practitioners in Africa and elsewhere working on research and innovation issues pertinent to Africa.

1.2 Outline of the paper

The rest of the paper is structured as follows: **section 2** explores literatures on capabilities, covering among others technological, innovation, social and political system capabilities, then draws from the literature to construct a conceptual and analytical framework for the ensuing empirical interrogation of whether and how governance capabilities can be strengthened in order for research and innovation to increase their contribution in Africa's quest for industrial, economic and social development. **Section 3** builds on the literature review to outline the methodology for the document reviews and stakeholder interviews that were carried out, while **Section 4**, organised around the governance capabilities, provides and analyses findings of the data collection processes. **Section 5** advances some conclusions on optimising governance capabilities for research and innovation systems in Africa.

2.0 LITERATURE REVIEW

In this section, we will briefly review different types of capabilities required by an innovation system, building a case for why governance capabilities, the main focus of this paper, are a crucial lens to focus on in Africa. The focus of the paper is inspired not only by a lack of detailed and nuanced analysis of governance capabilities in literatures focusing on African research and innovation systems, but also by a desire to illustrate instances where governance capabilities, couched in historical and broader contextual realities, would strengthen approaches and mechanisms for financing research and innovation and entire

² The SGCI works with 15 councils in Kenya, Rwanda, Uganda, Tanzania, Ethiopia, Cote d'Ivoire, Burkina Faso, Senegal, Ghana, Zambia, Mozambique, Botswana, Malawi, Namibia and Zimbabwe.

innovation systems. This paper is in agreement with mainstream literature on innovation and development that different types of capabilities are required for countries to develop. It was widely held for a long time, especially by economists, that differences in development levels across countries could be explained by one single factor, namely differences in the amount of accumulated capital per worker (Solow, 1956; Fagerberg, 1994). From the 1960s onwards the idea that differences in development are mainly caused by technological differences received increasing support (Gerschenkron, 1962). The debate has since progressed beyond this, with different capabilities being recognised and seen to be crucial in development trajectories, singly and in tandem with others. The argument that capability building is a precondition for successful catch-up received further backing from a series of empirical studies of industrialization processes in Asia and Latin- America undertaken during the 1970s and 1980s (Kim, 1980; Fransman, 1982; Fransman and King, 1984; Dahlman et al., 1987; Lall, 1987, 1992). The successful catch-up of a number of “newly industrializing” countries in the 1970s and 1980s (the NICs) also served as inspiration for the development of new perspectives on the dynamics of the global economy that put the development of appropriate technological activities (and other capabilities) at the core of the analysis (Fagerberg, 1987, 1988; Dosi et al., 1990; Verspagen, 1991; Fagerberg and Godinho, 2004).

Technological capability, agreed to be a moving target in constant need of improvement, has been used in a large number of studies at various levels showing progressive broadening along the way (Romijn, 1999). Although initially developed for analyses of firms, it has also been applied to industries and countries. Sanjaya Lall, in a survey (Lall, 1992), emphasized three aspects of “national technological capability” as he phrased it; the ability to muster the necessary (financial) resources and use them efficiently; skills, including not only general education but also specialized managerial and technical competence; and what he called “national technological effort”, which he associated with measures such as R&D, patents and technical personnel. He also noted that national technological capability does not only depend on domestic technological efforts but also on foreign technology acquired through imports of machinery or foreign direct investments (Fagerberg and Srholec, 2008).

2.1 Capabilities in innovation and development

The crucial role of technology in development processes is widely recognised, as is the fact that appropriate technological capabilities require other complementary factors in order for economies to be able to catch-up or leapfrog in their development trajectories. Concepts such as “social capability” (Abramovitz, 1986), “technological capability” (Kim, 1980, 1997), “absorptive capacity” (Cohen and Levinthal, 1990) and “innovation system” (Lundvall, 1992; Nelson, 1993; Edquist, 1997) have been suggested and a burgeoning empirical literature has emerged focusing on these aspects of development (Fagerberg and Godinho, 2004). The concept of “technological capability” refers to the ability to develop and exploit knowledge commercially. An important element of this is the ability to innovate, what Kim (1997) termed “innovation capability”. Beyond these two, studies by Gerschenkron (1962) in which he looked at a number of European countries relative to the leading economy then, Great Britain, concluded that in order to succeed in catching up, less advanced countries did not only need technological capabilities, but ‘new institutional instruments’ i.e. organisations capable of identifying the most promising options ahead and muster the necessary resources for exploiting these opportunities (Fagerberg and Srholec, 2008). While focused on investment banks and their critical role in mobilising resources for development, Gerschenkron’s work is

acknowledged to have pointed to a wider set of requisite capabilities for development (Shin, 1996). Fagerberg and Srholec (2008) point out four different dimensions of these capabilities, namely “innovation system”, “governance”, “political system” and “openness”, which they used to explore the extent to which cross-country differences in capabilities may help us understand why some countries excel economically while others continue to be poor.

In a similar vein to governance capabilities, Moses Abramovitz, arguing along similar lines as Gerschenkron, suggested that differences in countries’ abilities to exploit the potential for catch-up may to a large extent be explained by differences in what he called “social capability” (Abramovitz, 1994) which he viewed not so much as individual skills, but rather what organizations in the private and public sector are capable of doing and how this is supported (or hampered) by broader societal factors (Fagerberg and Srholec, 2008). Some of the aspects of social capability that he emphasized as being particularly important are: managerial and technical competence; a stable and effective government, capable of supporting economic growth; financial institutions and markets capable of mobilizing capital on a large scale; and the spread of honesty and trust in the population.

The concept of “social capability” soon became very popular (Abramovitz, 1994) and part of a wider body of scholarly, policy and practice literature demonstrating that the catch-up of not only Japan (Johnson, 1982) but also other so-called “newly industrializing countries” in Asia (Amsden, 1989; Wade, 1990; Kim, 1997) were associated with conscious, system-wide capability building as envisaged by Gerschenkron and Abramovitz. Similarly, Lall (1992), in making a distinction between technological capabilities proper and their economic effects, he highlighted the incentives that economic agents depend on from political decision making (governance system) or from more long-lasting institutions (the legal framework, for example).

Meanwhile, the observation that technological and social factors interact in the process of economic development not only spoke to the need to understand a broader set of interactions, but contributed to development in the 1980s of a new systemic approach to the study of countries’ abilities to generate and profit from technology, the “national innovation system” approach. The concept, was first used by Christopher Freeman in an analysis of Japan (Freeman, 1987), and soon became a widely used analytical tool by researchers studying interactive processes underlying a country’s technological and economic development (Lundvall, 1992; Nelson, 1993; see also Edquist, 2004 for an overview). Studies by Fagerberg and Srholec (2008) show that although a well-functioning innovation system is an essential prerequisite for development, it is not sufficient. Good governance is critical for the ability to realize the desired economic results. They further point out that countries that succeed in developing and sustaining strong innovation capabilities and well-functioning systems of governance do well economically while those that fail tend to fall behind (ibid). Their conclusion that what matters most for success is a well-functioning innovation system and good governance (ibid) inspires the argument for this paper.

In particular, this paper takes off from the premise that a wide range of studies have focused on innovation systems in Africa, their functions, roles and improvement potentials, for example; Lundvall et al (2001) on analytical applicability of the innovation systems concept in ‘The Making of African Innovation Systems’; Oyeyinka and McCormick (2007) on industrial clusters and innovation systems in Africa; Larsen et al, 2009 on organising African agribusiness as innovation systems; Juma (2010) on African health innovation systems; Muchie and

Baskaran (2017) on sectoral systems of innovation and Africa's development; and Watkins et al (2015) with a critical analysis of the innovation system actors in development and diffusion of innovations. What we have observed as missing in our review of these and other key literatures is the aspect of governance capabilities and their overarching role in shaping the emergence and performance of innovation systems.

2.2 Why governance capabilities matter for research and innovation

Defining governance broadly as the process of designing, implementing, and coordinating policy mixes (diagnostic, design, and execution capabilities) (Cirera and Maloney, 2017), this section, will briefly discuss the role and importance of governance capabilities in ensuring consistent decision making in support of research and innovation. The contention, and indeed the evidence is that innovation has moved well beyond being desirable, to being an essential capability for economies. Defined as the introduction of new products, technologies, business processes, and ideas in the market, as well as the invention of new ideas; innovation drives Schumpeter's creative destruction process (Schumpeter 2008, originally published in 1942), underlies modern growth theory, and is the critical ingredient in historical accounts of how countries achieve prosperity. Because research and innovation involve risk and managing many unknowns and uncertainties, it follows that for the two to be part of strategic options for sectors and countries, they should be integrated into comprehensive innovation governance structures. Governance structures need to be well thought through, starting with a breakdown of the essential parts of the research and innovation continuum, and from there identifying the essential parts of the governance capability.

Governance capability is the power or ability of an organisation to perform its mandate (Tilley et al, 2015). There is a distinction between competency (for individuals), capability (for organisations) and capacity (for systems). Governments and other actors in research and innovation require capabilities for policy across four key dimensions, namely: rationale and design of policy; efficacy of implementation; coherence of policies across the National Innovation System (NIS); and policy consistency and predictability over time (Cirera and Maloney, 2017)

In order to be able to perform well in these dimensions, governance mechanisms, like innovation activities, need not only to be properly designed and thought-through, but also require proper funding mechanisms, scope definitions, appropriate targets, time frames, realistic and flexible measurements, a fair level of agility, a tight well-honed reporting plan and a set of evaluation metrics (Hobcraft, 2014). Under-resourced and under-staffed governance structures often struggle to maintain cohesion between research and innovation efforts with strategic goals, let alone providing agility along the continuum, for example, the flexibility any early stage discovery and piloting of a concept may require. Further, without clear, robust, open and transparent governance systems and structures, stakeholders do not only struggle to understand how innovation is being supported, but it also leaves decision-makers struggling for credibility, trust and confidence to carry out their duties, an atmosphere which hampers overall performance of the entire innovation system (Mugwagwa et al, 2019). Effective governance mechanisms can resolve potential conflicts, aid allocation of resources, be a great early warning post for changing scope, adjusting ambition up or down and can be the 'working group' that alerts and informs besides supporting and encouraging innovation (Hobcraft, 2014). In arguing for development of governance capabilities, this paper emphasises the historical and context-contingent nature of the capabilities that are required

due to the fact that the capabilities that may have been useful for certain countries or sectors at some point in history may not necessarily be the important capabilities for African countries now. The precise set of capabilities required is varied and contextual, and it is the intention of this paper to illustrate that governance capabilities put countries in a better position to make the most of technological, financial, social, innovation and political system capabilities.

2.3 The conceptual and analytical framework

The paper’s rationale, data collection, analysis and interpretation perspectives are informed by neo-Schumpeterian thinking which argues that systems of innovation do not emerge from industrialisation or technological advancement efforts alone, but as Edquist (1997) notes, from processes that are ‘lengthy, interactive and social [and in which] many people with different talents, skills and resources have to come together’. Innovation systems require deliberate development and embedding within country-specific institutional and technological contexts (Lundvall, 1992; Pyka et al, 2009) and we extend this to governance capabilities by developing a matrix (Table 1) which brings together ‘social capabilities’ (Abramovitz, 1994) as inputs and ‘governance capabilities’ (Cirera and Maloney, 2017) as outputs. We use this matrix as both a conceptual framework, for visualising the coming together and interplay between different capabilities, and analytical framework, for separating and assessing singly then collectively the effect of the different components on emergence and performance of research and innovation governance mechanisms.

Table 1: Conceptual and analytical framework integrating social and governance capabilities

Social Capabilities	Governance Capabilities
Managerial and technical competence;	Good policy design rationales
Stable and effective government, capable of supporting research systems* (narrowed down from economic growth);	Efficacious policy implementation
Financial institutions and markets capable of mobilizing capital on a large scale;	Coherent of policies across the National Innovation System (NIS)
The spread of honesty and trust in the research system* (narrowed down from population)	Consistent and predictable policy over time
INPUTS	OUTPUTS

Source: Developed by authors, adapting Abramovitz (1994) and Cirera and Maloney (2017)

Our argument for bringing these components together in this way draws from the fact that governance mechanisms are both about structural and relational attributes of the political economy, and both aspects are amply captured when social and governance capabilities are brought together. They each also encompass other requisite capabilities, from technological and financial to political system and innovation capabilities, leading to the integrative framework that we are deploying to organise and interpret the findings of our study. Each governance capability (output) can be the result of one or more social capabilities (inputs), and our argument is that the more the social capabilities that contribute to a single governance capability, the stronger and more durable that governance capability will be. We draw on literature and our findings to illustrate our argument in the findings analysis section.

3.0 METHODOLOGY

This paper draws from a study which had a broader objective of identifying and analysing “new approaches for funding research and innovation in Africa”. Guided by the research questions presented earlier in the paper, the study ensured consistency, rigour and validity through four carefully planned research stages which were implemented iteratively between July and December 2018. **Stage one** involved collecting and analysing published and grey academic, policy and practice literature on research and innovation in Africa broadly, and funding models in particular. This informed **stage two** of the research, which covered two related aspects – development of a semi-structured research questionnaire/instrument with clustered questions and sub-questions; and drawing up of a participants’ list. This paper particularly draws from a total of 32 participants that were targeted, 15 of them being officials in science granting councils of countries participating in the Science Granting Councils Initiative (SGCI) and 17 were from research organisations, funding agencies or policy bodies in Africa or elsewhere (key informants purposively targeted based on researchers’ experience and literature reviews). In **stage three**, the research instrument was administered via email in all the cases, with varying response rates among the respondent clusters; 73.3% (11/15) for SGC respondents and 35.3% (6/17) for academic, policy and practitioner, including private sector, respondents in Africa and elsewhere. Supplementary data collection and findings validation was done through engagements with participants (15 direct engagements) at the Annual Forum of SGCI partners in November 2018 in Ivory Coast. Besides the relatively low response rate among the second category respondents, there were no other significant constraints or limitations to the research process. Respondents from the different functional areas (academia, policy, practice) showed a diverse spread over, and engagement with research and innovation activities in different countries, sectors and time periods, allowing for a nuanced and diverse understanding of the role and contribution of research and innovation in particular and governance mechanisms broadly across different countries. This wide range of respondents was important for eliciting and cross-checking the diverse set of reflections on the issues being investigated. In **stage 4**, data from the research instrument and stakeholder engagements was collated, anonymised, aggregated and analysed through the analytical framework (Table 1) using Thematic Analysis (Boyatzis, 1998) leveraging a combination of themes drawn from literature and from the research findings.

4.0 ANALYSIS AND DISCUSSION OF FINDINGS

4.1 New funding approaches

Our study revealed that the importance of research and innovation is rated between medium and high, and is increasing in most of African countries (Mugwagwa and Banda, 2019). This is demonstrated by institutional and policy provisions for STI which have been instituted in the last few years. A number of dynamic new funding models have been developed, adopted and deployed in countries and sectors to deal with realities of decreasing funding for research and innovation from traditional sources. These models, which encompass partnerships, co-funding and multi-disciplinary approaches for basic and applied research in areas such as energy, agriculture, water and sanitation, health, climate change, among others seek to ensure context-driven, efficient and effective utilisation of resources (see Mugwagwa and Banda, 2019)). Our study confirms the reality that different countries and sectors work best with particular funding approaches and that there is need for accommodation of diverse funding models and means of optimising and assessing their impact. SGCs and line ministries should therefore work closely to come up with robust procedures for identifying and consolidating desired sector outcomes upon which policymaking should focus. Access to and deployment of effective approaches for funding research and innovation require strong leadership and oversight from governments and SGCs, especially with respect to identifying and balancing the disparate requirements of different sectors and areas of application with their points of commonality.

Beyond tactical addressing of current socio-economic challenges, African governments need to develop unifying long-range, yet operable national ideologies on the role of research and innovation, modelled around the impending demographic dividend and leveraging the continent's natural resource endowment for economic progress. An example is how Japan attained universal health coverage in the early 1960s, way ahead of the rest of the world by defining access to health as a 'nation building' imperative. Meanwhile, as part of their mandate to support and manage research programmes, SGCs could assist researchers to generate research and innovation impact evidence and sustained relevance which will result in political will and commitment to funding research and innovation. There is a lot of data generated by various agencies, e.g. the African Science, Technology and Innovation Indicators programme (ASTII), which can be utilized more for decision-making at national and sectoral levels. Governance mechanisms serve as a source of and will benefit from clearly identified entry points for different actors and funding options. This means that for the purposes of defining research and innovation policy objectives and identifying appropriate approaches for funding research and innovation, it is important for the different stages of the research and innovation value chain to be continuously mapped out (by sector where possible), from basic research to products. SGCs could lead this as part of their objective of strengthening research and evidence-based policies, and enhancing their own governance capabilities.

4.2 Rationale and design of policy

Designing policies appropriate to the local context requires a solid diagnosis of the problem to be redressed, hence, a substantial effort is necessary to guarantee that policy solutions are aimed at the correct problem (Cirera and Malony, 2017). Put differently, effective research and innovation governance mechanisms should be aimed at addressing the problems that

have led to or sustained unfavourable conditions for actors in the system, which could include information asymmetries, knowledge gaps, financing inadequacies, coordination and systemic failures (Arrow 1962; Nelson 1959). In this analysis, and looking particularly at the harnessing and deployment of resources as a function of governance (Stoker, 1998), the different funding mechanisms highlighted which encompass co-funding, partnerships and multi-disciplinary working, were deemed to be particularly important in the various countries at this point in time for different reasons which included relevance to local contexts, sufficiency of funding provided, more rapid application turnaround time, inclusion of new researchers and wider scope for cross-sectoral collaboration. Relevance to local contexts and scope for cross-sectoral collaboration were particularly viewed as key rationales for policy design. In a majority of the countries, with the exception of Kenya, respondents said research and innovation would have suffered adversely without the new funding models. Among the reasons highlighted why this would have been the case were that with the new models there is more standardisation of research applications, there is better resource tracking and accountability among recipients, and there are stronger institutions. In South Africa, the new models were said to have led to:

'... continuous and consistent funding to support excellent research, increased international competitiveness of South African researchers and better science policy-linkages' (Respondent AS, Aug 2018).

Across the countries, the different models were also seen as being in harmony with global, continental and sectoral development trajectories charted by among others, SDGs, continental development agendas such as Agenda-2063, STISA-2024, NEPAD and AU programmes such as ASTII, AMRH & CAADP (Consolidated African Agricultural Development Plan), various national development agendas and programmes of multilateral agencies. Additionally, adoption of the new funding models was said to be benefitting from increasing access to knowledge resources, internationalisation of the research enterprise and increasing political and collective will towards research and innovation in various African countries. According to the respondents, as shown in Fig 1 below above, sectoral and national priorities are increasingly becoming key drivers of funding for research and innovation, compared to organisational, funder or researcher priorities as was the dominant case in the past.



Figure 1: Important priorities driving funding for research and innovation; score of 1 means most important and score of 5 least important

There were mixed views on whether funding models should be locally-derived or not, with 64% of respondents saying they preferred locally-derived models, 27% expressing no preference while 9% said they should not be locally-derived, see Fig 2 below.

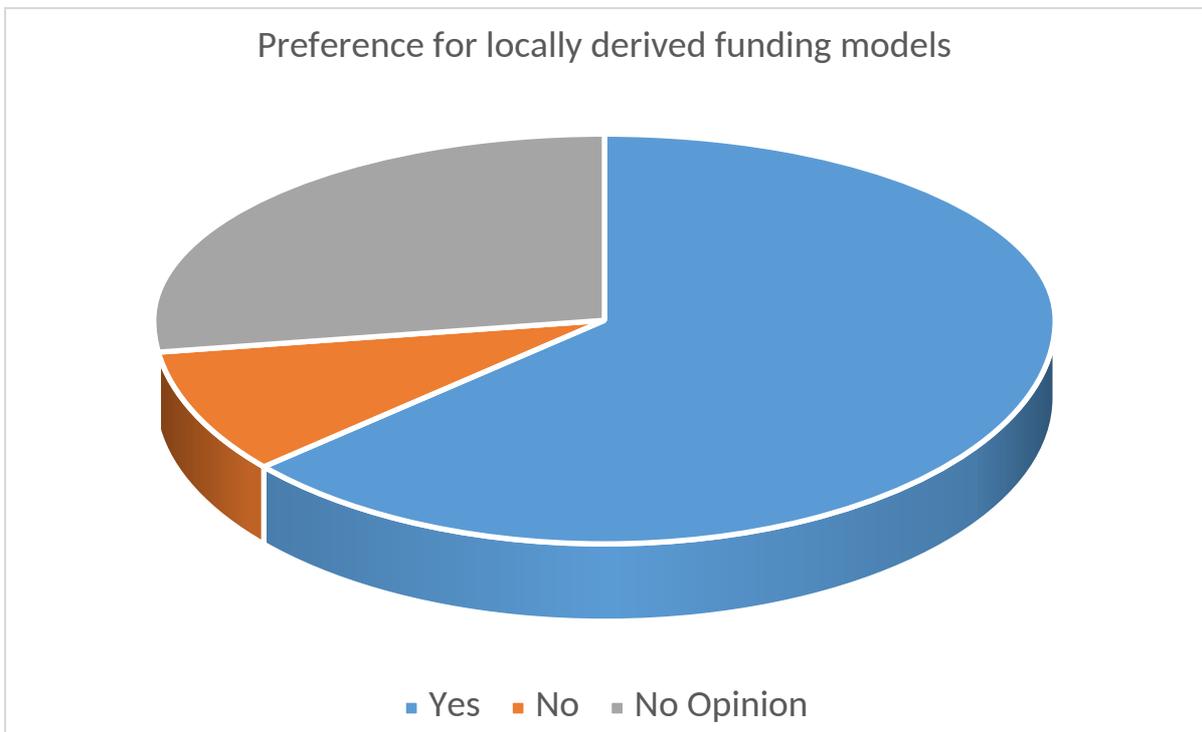


Figure 2: Preference for locally derived models

What was common across the responses was that the model of choice should be compatible with local contexts, as illustrated by some of the respondents below:

In favour of locally-derived models;

“It takes into context the entire national system of innovation that the research funding would address which includes research infrastructure, human resource as well as commercialization of research output” (Respondent G, Aug 2018).

“Implementation is based on our context. The models can leverage the limited resources to realize maximum output’ (Respondent K, Aug 2018).

“Because locally derived funding models would be more responsive to local needs and aspirations” (Respondent M, August, 2018).

“Because the local contextual factors/problems can determine and inform the relevant choice of a suitable funding model while learning from funding models of other countries” (Respondent FB, August, 2018).

And not in favour of locally-derived models only;

“A combination of options should be considered, informed by local context, that will best facilitate and impact the intent of the funding. There should therefore not be an exclusive preference for locally-derived funding models” (Respondent AS, August, 2018)

In relation to the above, some specific examples of locally-derived funding models for research and innovation that could be scaled up and adopted across the continent were suggested from Ghana and South Africa, as elaborated by respondent quotes below:

‘Funding for the establishment of Technology Transfer Centres in R&D institutions will promote research collaboration with the private sector thereby increasing research funding from industry to the institutions’;

‘The NRF created and established an innovative academia-industry links programme for development of human capital. In addition, a dedicated and well-resourced chairs programme in-country contributed significantly to research output, research capacity development, and international collaboration’

What is clear from the above observations is the importance of local contexts in driving the rationale for policy and practice. While the same research and innovation system actors and factors may be at play in different sectors and countries, what may vary is how they interact across different countries, and the reason why governance mechanisms that do not simply assume a diagnosis common in all countries are more effective (Cirera and Maloney, 2017). Rationale that is good for policy is always changing, and this highlights the need for on-going review of best practice at sectoral, national and international levels to consolidate knowledge about how deployment and implementation of STI policies and research and innovation approaches can be optimised. The reviews should include the use of existing and new funding approaches, and should include details about how a specific industry or component of the research and innovation value chain can engage with upstream or downstream processes.

4.3 Efficacy of implementation

In seeking to understand institutional adjustments that have accompanied the new funding approaches and how they had impacted implementation of research and innovation policies, we explored a number of issues with respondents, among them whether or not there had been changes in the drivers and priorities shaping decisions on funding research and innovation, changes that have been realised by institutions and researchers from use of new approaches, and the advantages accruing from use of the new approaches. Among different factors which influence choice of funding model for research and innovation, history of a particular model's use in developed and other developing countries was viewed as key. Even in this backdrop, there were several issues that were said to pose potential implementation challenges for the new models, which for a majority of the countries could be summed up as perennial under-resourcing of research and innovation, 'the lack of an implementation plan and an uncoordinated approach to ST&I' (UNESCO, 2016). While political will was said to be on the increase, it still remained insufficient, and had not translated into 'political action'. The following challenges were also mentioned, and were said to be equally important and in need of urgent attention: limited government financial resources, unfavourable institutional traditions, policy incoherence across sectors, mismatch between research priorities and developmental challenges, lack of long-term policy planning, rapid technological changes and poor strategic partnership choices.

Meanwhile, a number of implementation advantages of new funding approaches, reflective of institutional adjustments at different levels, were highlighted, as shown in Fig 3 below.

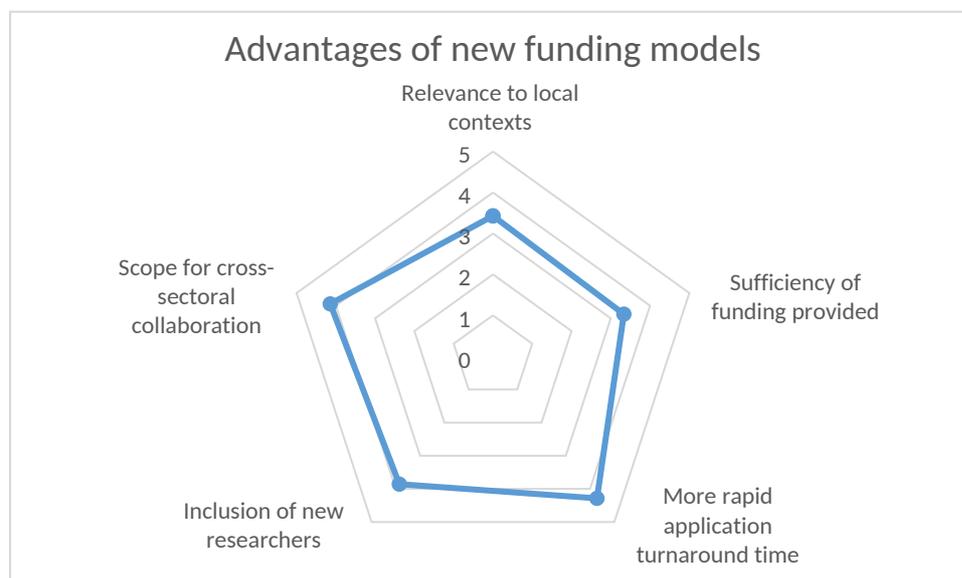


Fig 3: Implementation advantages of new funding models

Other institutional adjustments and reflections in policy framing were also noted which resulted in the new approaches being advantageous, for example a focus on responsibility and assured output (Kenya), emphasis on international competitiveness, consideration of transdisciplinary, multidisciplinary and interdisciplinary approaches; greater science-policy linkages (South Africa) and ensuring enhancement of human and societal benefits (Namibia). We draw from this that governance mechanisms for STI and attendant research and innovation funding models will be more effectively implemented when underpinned by an

understanding of the interdependent political, social, technical and economic factors that affect them. SGCs and governments should therefore use their considerable convening power to regularly bring together research, business, regulator, user and different other communities at national level to explore funding approaches that best promote the values and interests of African countries in a global context

Other adjustments noted were related to the need to reflect on and embed lessons from approaches that have been used in the different countries before. It was highlighted that lesson drawing should not only focus on what comes from other countries, but also what can be learnt from what has been tried locally, even in other sectors. In this regard, respondents referred to a number of previous approaches which they said could be leveraged to enhance local relevance and implementation of the new approaches. Malawi for example was looking at reviving government grant schemes for research and innovation based on the feeling that 'no donor can fund a country's national research priorities if the government itself does not prioritise funding them' (Respondent M, Aug 2018). Namibia was also rethinking

'allocation by the Central Government, because this is vital to ensure that research and innovation is targeting the solutions that enhance national research priorities and needs of the country as well as research and innovation infrastructure development' (Respondent AN, Jul 2018)

while in South Africa there were efforts to focus again on specific disciplines to strengthen and support research. According to one respondent;

'A competitive, bottom-up research agenda has been useful during the past 10 years, but there is a need to re-focus on specific areas of advantage and disciplines to strengthen the research system (e.g. mathematics, engineering)' Respondent AS, Aug, 2018).

Overall, there was a strong feeling that the multidisciplinary and partnership-based arrangements characterising the new funding approaches were benefitting from adjustments at multiple levels from the global to the national and sectoral which were increasingly in favour of collaborative arrangements. By broadening participation of different stakeholders and increasing levels of system openness, the arrangements were helping to address some of the perennial systemic failures around information asymmetry and coordination, inefficient resource deployment and utilisation, and lack of broad-based stakeholder appetite to contribute to research and innovation

4.4 Policy coherence, consistency and predictability

Given the cross-cutting and pervasive nature of science, technology and innovation, it is not surprising that governance mechanisms for research and innovation are the centre of many different factors, forces and voices, which tend to skew policy processes and outcomes in particular directions, in turn affecting the coherence, consistency and predictability of research and innovation policies. Respondents highlighted that among the dominant voices in the debates on research and innovation were international donors, NGOs and developed country aid programmes, especially those focused on health and agriculture. Regional economic communities, AU and NEPAD were also said to be dominant, as well as international philanthropists, venture capitalists and multinational companies. Stakeholders that were said to be missing or less visible in the debates included civil society organisations at local and stakeholder level; appropriately resourced African research and innovation think tanks; local

private sector, banks, venture capitalists and philanthropists; active parliamentary committees on STI lobbying for funding; and local small and medium enterprises.

As a result of or related to the stakeholder participation scenario above, some issues were said not to be adequately addressed or attended to in the debates on research and innovation, undermining policy coherence, consistency and predictability. These include the issue of compliance with continental declarations e.g. raising funding to at least 1 % GDP, where government rhetoric was not consistent with the funding commitment made. One respondent had this to say:

“National governments are not held accountable by appropriate regional economic communities such as AU/SADC and civil society bodies on their initiatives towards funding for research and innovation in their respective countries. As such, such governments do take a laissez faire approach towards funding for research and innovation. Even when there are certain legal and administrative instruments in place for S&T Fund, some national governments have not prioritised to make such a fund operational” (Respondent Z, Aug 2018).

This further underscored the lack of translation of political will into political action, which has been observed by other studies of the research and innovation terrain in Africa (e.g. Amankwah-Amoah, 2016 and UNESCO, 2016)

Other key issues that were highlighted as impacting policy coherence, consistency and predictability were: how to reach out to non-formal researchers and innovators across the continent; creation of a deliberate policy environment for private sector participation in research and innovation funding; harnessing mutually beneficial local partnerships to support R&I; sharing best practice on common/similar models for funding and governance that are unaffected by the political dimensions of the region; and relatedly risk mitigation from regime changes that affect policy and funding allocations approved by previous regimes. Consolidated national knowledge platforms on research and innovation are a key part of governance capabilities. Generation and sharing of knowledge is integral to research and innovation processes (Fagerberg and Srholec, 2008), and the more cohesively and efficiently these can be done within the research and innovation ecosystems, the greater the benefit that will accrue to different actors in the system, including researchers, decision-makers as well as entrepreneurs and other adopters of innovations.

It is clear from the foregoing that understanding and enhancing governance capabilities for research and innovation should be an ongoing process rooted in the political economy of the different countries (Chataway et al, 2018), and intended to provide an informed basis for developing synergies within and across African countries and for lesson drawing from countries elsewhere with similar politico- and socio-economic histories and realities.

5.0 CONCLUSIONS

The aim of this paper was to situate the on-going debates on funding research and innovation in Africa within the context of governance capabilities, looking specifically at rationales for policy design, efficacy of policy implementation and policy coherence, consistency and predictability. Guided by three broad research questions, the paper sought to highlight that

while the quest to explore new and innovative approaches for funding research and innovation is key, buttressing this within broader and overarching governance capabilities is an important dimension in the exploration of opportunities for ensuring context-driven, efficient and effective harnessing and utilisation of resources for research and innovation by African countries.

In order to accomplish the aim of the paper, a comprehensive study was conducted iteratively between July and December 2018 encompassing collection and analysis of published and grey academic, policy and practice literature on research and innovation in Africa broadly, and funding models in particular; development and administration of a semi-structured questionnaire/instrument with clustered questions and sub-questions targeting informants from science granting councils in 15 African countries, research organisations, funding agencies or policy bodies in Africa and elsewhere. Data from the research process was collated, anonymized, aggregated and analysed in a combination of themes drawn from literature and from the research findings. Linking back to the research questions and conceptual framework, this paper, as summarised in Table 2 below, broadly confirms the coming together and manifestation of different governance capabilities among the countries.

Table 2: Strength of governance capabilities

Social Capabilities	Governance Capabilities	Contributing Capabilities
(A,a) Managerial and technical competence;	Good policy design rationales	A, B, c, D
(B,b) Stable and effective government, capable of supporting research systems;	Efficacious policy implementation	A, b, c, d
(C,c) Financial institutions and markets capable of mobilizing capital on a large scale;	Coherent of policies across the National Innovation System (NIS)	A, B, c, d
(D,d) The spread of honesty and trust in the research system.	Consistent and predictable policy over time	A, B, c, D

Key: Caps = significant contribution; lower case = low contribution

From our analysis above and as other studies confirm (e.g. Papaioannou et al, 2018; Mugabe, 2013) there are strong levels of managerial and technical competence for oversight roles in the research and innovation systems across a majority of the countries, particularly Kenya, South Africa, Uganda and Ethiopia, which have resulted in locally-relevant policy design rationales and contributed strongly to policy consistency, coherence and implementation.

Further, the stability and effectiveness of national governments was also said to have improved a lot, facilitating good policy design rationales, policy coherence and a significant level of policy predictability over time. What this has not translated to, however, across most of the countries, is availability of adequate financial resources and appropriate funding mechanisms for the research and innovation value chain. Similarly, our analysis reveals an increasing level of trust and honesty in the research and innovation system, buoyed by increasing levels of openness, knowledge-derived credibility and consistency on the part of most of the SGCs. This, however, still needs to result in more efficacious policy implementation and policy coherence.

There is increasing awareness among stakeholders of the need for policy rationales to be informed by local contexts, for openness, coherence and predictability measures which respond to as well as cushion systems from funding deficiencies, sub-optimal decision-making, information asymmetries and coordination failures. Effective funding of research and innovation from basic research up to launch of products on markets will require context-relevant governance approaches which balance needs and optimise the roles of different actors. Attaining and sustaining these requires sufficient attention to development and deployment capabilities, alongside technological, financial, social and innovation capabilities.

Key actors in the funding as well as governance of research and innovation such as SGCs, national governments, private and public sectors, non-profit organisations and development agencies can leverage their access to global knowledge resources to help countries develop or reconfigure their STI policies to be not only forward-looking and agile, but also to be influential towards strategic goals. Strategies for funding research and innovation are in urgent and constant need for alignment with other policies such as national industrial, health, agricultural and education strategies and other national developmental visions. In the final analysis, governance mechanisms for research and innovation need an honest balancing of capabilities with tasks, which may well entail working on a selective set of issues rather than trying to develop or import a full set of institutions and policies from elsewhere.

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Conflicts of interest

All authors declare no conflict of interest. The funding sponsors had no role in the design of the study; the collection, analyses or interpretation of the data; the writing of the manuscript; or the decision to publish the results.

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