Funding Research in Africa: Landscapes of Re-institutionalisation

RIGAS ARVANITIS, JOHANN MOUTON and ADELINE NÉRON

This article begins with an overview of recent and current trends in scientific output in Africa. The focus is on how global dynamics and foreign funding support are directly affecting structural aspects of scientific research. It examines the fundamental role of foreign programmes and new forms of academic cooperation in African science. This includes a discussion of multilateral or transcontinental agreements and local universities, the role of private philanthropy and public institutions, trends in domestic expenditure on research and innovation, and how these are linked to the recent positive upturn in scientific production in many African countries.

Keywords: Academic research, scientific infrastructures, African institutions, philanthropy, research policy, International Aid

Introduction

Academic research has been conducted on African research systems since at least the 1980s (Gaillard & Waast, 1988). The area of science, technology and higher education has received increasing attention. Nevertheless, there is still a dearth of studies on the dynamics of higher education or science and technology when compared to other continents and specifically bibliometric studies of publication outputs and trends.

Bibliometric studies in the early 2000s showed very little if any growth in the numbers of publications authored or co-authored by African scientists (Arvanitis et al., 2000; Narváez-Berthelemot et al., 2002; Tijssen, 2007; Waast & Gaillard, 2001). In his paper, Tijssen showed that sub-Saharan Africa's share of world

Rigas Arvanitis (corresponding author), Centre Population et Développement (Ceped), Université de Paris Cité, Institut de Recherche pour le Développement, Paris, France; Global Research Institute of Paris (GRIP), France. E-mail: rigas.arvanitis@ird.fr
Johann Mouton, Centre for Research on Evaluation, Science and Technology at Stellenbosch University and the DST-NRF Centre of Excellence for Scientometrics and STI Policy, South Africa.
Adeline Néron, IFRIS Post-doctoral Researcher, Centre Population et Développement (Ceped), Université de Paris Cité, Institut de Recherche pour le Développement, Paris, France.

Science, Technology & Society (2022): 1–17
SAGE Publications Los Angeles/London/New Delhi/Singapore/Washington DC/Melbourne
DOI: 10.1177/09717218221078235

scientific papers declined from 1% in 1987 to 0.7% in 1996 (Tijssen, 2007). This diminishing share of African science overall did not reflect a decrease in absolute sense, but rather an increase in publication output less than the worldwide growth rate. Africa had lost 11% of its share in global science since its peak in 1987; sub-Saharan science had lost almost a third (31%). The countries in Northern African, Egypt and the Maghreb countries (Algeria, Mauritania, Libya, Morocco and Tunisia) accounted for the modest growth of the African share of the worldwide output during the years 1998–2002.

Bibliometric analysis of research output is only one measure of the relative decline of research and scholarship at many African universities. Numerous studies covering the period between 1990 and 2005 demonstrated quite convincingly that research at former well-resourced and supported institutions, such as Makerere University in Uganda, Ibadan in Nigeria and University of Dar es Salaam in Tanzania, had deteriorated; that research infrastructure and the general state of laboratories at many institutions had suffered from a lack of maintenance and timely replacement of old equipment. In addition, the generally poor quality of library resources has not improved significantly, with many university libraries not even using automated management systems; the demand for sufficient research funding for ongoing research and scholarship continued as does the need for proper research management and support at most of these institutions (Mouton, 2008).

These studies also provided some initial explanations for these changing trends in scientific performance. The first set of explanations focused on the decline of university research in Africa in the late 1990s. International forces associated with the globalisation of trade in the 1980s and 1990s had devastating effects on national economies. The severe pressure on import capacity and essential economic and social investments increased the dependence of the typical sub-Saharan African country on external aid. Concomitantly, international agencies, most notably the World Bank, privileged expenditure on primary education at the expense of higher education (Psacharopoulos et al., 1986). As a result, many universities were thrown into financial crisis, with laboratories and libraries suffering from a lack of maintenance, timely replacement of equipment, overcrowded lecture rooms, the decline in scholarship and subsequent flight of top academics. Case studies covering the period 1990–2005 demonstrated that research at former well-resourced institutions such as Makerere University (Uganda), Universities of Ibadan (Nigeria) and Dar es Salaam (Tanzania) had deteriorated (Cloete et al., 2011).

The cumulative effect of funding policies, massive growth in student enrolment in higher education and continuing political instability in many countries created what was termed the ‘de-institutionalisation’ of science (Mouton, 2008). The fragility of the academic communities and lack of confidence by authoritarian governments—especially in the Arab countries(El-Kenz, 1997; Hanafi & Arvanitis, 2016)—as well as societies themselves in science produced locally, created a weak ‘social inscription of science’ (Waast, 2006). At the time these studies were conducted, it was concluded that sub-Saharan scientific institutions

remained susceptible to political and military upheavals, severely under-resourced and missed articulation of science governance with ministerial responsibilities.

However, more recent studies have shown a reversal in this trend, with Africa's scientific output increasing in real numbers (CREST, 2020). In addition, its share of world output more than doubled the growth of Africa as far as world science production is concerned (Confraria, 2014; Mouton & Boshoff, 2010; Pouris & Ho 2013; UNESCO, 2015; World Bank, 2014).[1] Under the auspices of the New Partnership for Africa's Development (NEPAD), the African Science, Technology, and Innovation Indicators initiative from the African Union confirmed this trend in Reports entitled *African Innovation Outlook* (NEPAD, 2019).

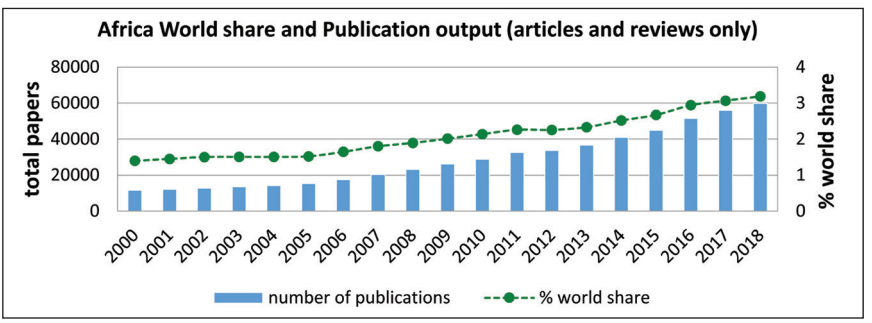
Figure 1 shows that Africa has increased its absolute number of scientific articles and reviews from 10,905 in 2000 to 69,657 in 2018. This translates into an increase in Africa's share of world publications from 1.5% in 2000 to 3.5% in 2018.[2]

Even with a smaller portion of the world literature and a skewed distribution on the continent, its rapid growth of participation in world production surpasses the world growth rates over the same period. This increased contribution to scientific production is particularly true for thirteen major fields measured by indexes of specialisation (Table 1). These fields recorded specialisation index scores of more than 1.5 (with a threshold of at least 2,000 papers for the period 2015–2008). It is especially noteworthy that three fields—tropical medicine, parasitology and infectious diseases—are fields where scientists in Africa are significantly more active compared to the world average scores for other regions.

These thematic priorities reflect both the material realities within African countries and pre-existing and new partnerships and collaborations in domains where North–South partnerships are dominant. In this matter, single-institution articles (no collaboration) and collaboration between countries of the continent

Figure 1

Africa World Share and Publication Output (articles and reviews only)



Source: CREST analysis of own version of the Web of Science database (February 2021).

Table 1

Specialisation Index Scores for Scientific Fields (2015–2018)

Scientific Fields	*Specialisation Index Scores*	*No. of Publiactions*
Tropical medicine	7.45	4,621
Parasitology	4.74	3,963
Infectious diseases	4.11	8,530
Public, environmental and occupational health	2.65	12,170
Agronomy	2.32	3,386
Entomology	2.11	1,857
Water resources	1.85	4,138
Agriculture, dairy and animal science	1.76	1,850
Ecology	1.72	4,495
Plant sciences	1.71	5,615
Chemistry, medicinal	1.59	3,179
Veterinary sciences	1.59	3,118
Health care sciences and services	1.58	2,722

Source: Web of science data. Our own calculations.

(African collaboration) appear to be negligible compared to articles where there is some collaboration between Africa and the rest of the world (intercontinental collaboration). In fact, single-authored publications have declines from 16% of all papers in 2000 to only 5% in 2019. Conversely, the percentage of papers that involved collaboration with countries outside Africa increased from 46% in 2000 to 63% in 2019. The other interesting trend is the decline in national collaboration (namely, collaboration between institutions within the same country) which has declined over the same period from 38% to 30%. These trends point to the fact that most African countries are not only increasingly collaborating (or at least co-authoring) with scientists outside Africa but also increasingly not co-authoring with scientists in their own countries. Taken together, these trends are another indicator of weak national systems. In strong science systems (such as the USA, UK, Germany and others), national collaborations are at least as prevalent as collaborations with scientists outside these countries (Mouton et al., 2019).

Beyond what bibliometric studies can indicate, research trends on the continent require more in-depth analyses of such partnerships. We hence construct our main argument around three theses: configurations of sources of funding, governance of international funding and structural effects of funding.

Different Configurations of National and International Sources of Funding

Many African governments have committed to increasing their Gross Domestic Expenditure on Research and Development (GERD). GERD is generally regarded as a measure of how dedicated a country is to supporting research. Table 2 captures the most recent data on the proportion of Gross Domestic Product (GDP) that is expended on R&D in these countries (NEPAD, 2019; UNESCO IUS, 2021[3]). The table shows quite clearly that not a single African country has attained the goal

Table 2

Gross Domestic Expenditure on R&D (GERD) as Percentage of GDP

	African Innovation Outlook (NEPAD, 2019)	*UNESCO Institute for Statistics (2019)*
Country[a]	*GERD as % of GDP*	*GERD as % of GDP*
Botswana	0.54 (2013)	0.54 (2013)
Burkina Faso	0.18 (2009)	0.22 (2014)
Cameroon	n/a	0.12 (2015)
Côte d'Ivoire	n/a	0.10 (2016)
Ethiopia	0.62 (2013)	0.27 (2017)
Ghana	0.47 (2008)	0.23 (2007)
Kenya	0.79 (2010)	
Malawi	1.70 (2007)	n/a
Mozambique	0.38 (2014)	0.34 (2015)
Namibia	0.40 (2013)	0.34 (2014)
Senegal	0.48 (2008)	0.58 (2015)
South Africa	0.83 (2017–2018)	0.83 (2017–2018)
Tanzania	0.38 (2010)	
Uganda	1.17 (2014)	0.17 (2014)
Zambia	0.37 (2008)	n/a
Zimbabwe	0.2 (2005)	n/a

Source: African Innovation Outlook and UNESCO Institute for Statistics (2019).

Note: [a]For some countries, data do not include the business enterprise sector, private non-profit institutions/organisations or the higher education sector. We have added a second column to include the latest available UIS statistics on R&D investment for the selected countries. We must, however, add an important caveat when inspecting this table. Some of the country data—as submitted to the UIS/UNESCO and OECD—have never been independently validated. This is certainly true for the reported GERD/GDP data for Malawi and Uganda. The reader is, therefore, advised to treat these data with caution.

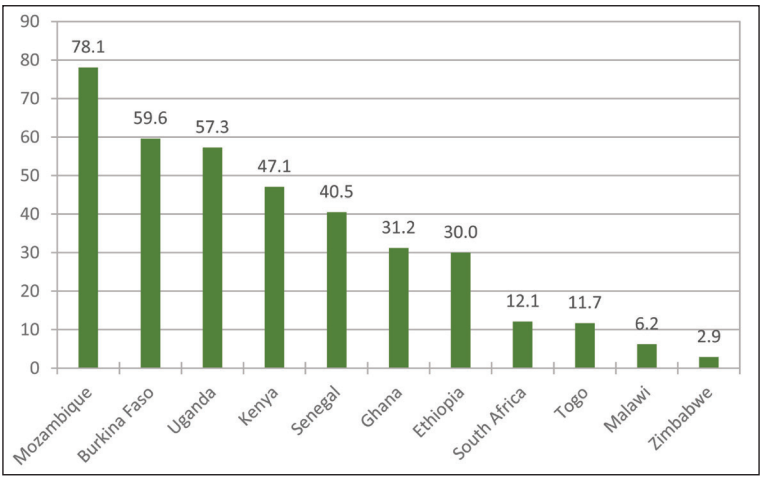
of spending at least 1% of GDP on R&D—a target that was agreed upon by all African countries in 2005 and which is repeatedly stated in most national science policy documents.

The second *African Innovation Outlook* (NEPAD, 2014) reported GERD by funding sources. Government funding of R&D activities is significant. Notably, Ghana's government expenditure is the highest, accounting for 68% of its research expenditure, and records the lowest expenditure from its business sector at 0.1% in 2010. In the majority of the countries, contributions from the business/private sector are low. The outlier is South Africa, where the private sector contributes just over 35% of the total R&D expenditure. It was also the least reliant on foreign funding, with only 16% being from outside sources. This report indicates, as shown in Figure 2, that some countries such as Mozambique, Burkina Faso and Uganda received more than 50% of their R&D funding from foreign sources.

To illustrate further this over-reliance on foreign funding, we can cite the example of a large and prestigious research university, the Makerere University, Uganda's flagship university (Hydén, 2017, p. 97). Of all of Makerere's funders in 2000–2012, the Uganda National Council for Science and Technology was the only local funder, with less than 1%.[4] Like many universities, Makerere has

Figure 2

Proportion of International Funding for R&D by Country (2010 or latest year)



Source: ASTII R&D surveys 2010 or latest year available.
Note: These statistics remain the most recent and comprehensive. Investigation of the same indicator in the Third African Innovation Outlook (2019) reveals no additional nor more recent data. The same applies to the database of the UNESCO Institute of Statistics as accessed on 21 February 2021. http://data.uis.unesco.org/#

sustained much of its research activities through the assistance of external funders, among which two North European countries (representing 47%), two large private American foundations (19%), the U.S. Agency for International Development (USAID) (13%) and the European Union (EU) (4.6%).

Nonetheless, national investments by African governments and reliance on foreign funding appear in various configurations on the African continent, and we examine these patterns as follows. Science granting councils and agencies such as National Commissions for Science and Technology, National Science Councils and National Academies are essential actors in national research systems. They are crucial 'intermediaries' in the financial and technical support to R&D in a country. The creation of science granting councils (SGC) and competitive research funds is of a rather recent origin in Africa (Currie-Alder et al., 2018). The past decade shows an increase in the establishment of dedicated councils or agencies. An empirical study examined the strategic priorities, objectives and practices of SGC in seventeen sub-Saharan countries (Mouton et al., 2014). One of the main findings of this study relates to the diversity of science funding institutional configurations. Box 1 shows examples of how these questions are addressed differently according to countries.

Four models capture the most commonly found arrangements for public research funding. First, a *simple situation* is where the government delegates its funding

Box 1

Different Cases of Relations to Science Granting Councils and National Funding Agencies

Ghana: A science granting council serving the interests of the government and a Fund serving the interest of the council
In Ghana, the Council for Scientific and Industrial Research (CSIR) coordinates and administers the Science and Technology Research Endowment Fund (STREFund). STREFund is an independent funding mechanism by which the Ministry of Environment, Science and Technology ensures that the CSIR is serving the government's interests in its administration of the Fund through co-representation. STREFund is governed by a board of trustees representing the CSIR, the Association of Ghana Industries, the Ministry of Finance and Economic Planning, Universities, the National Council for Tertiary Education, the Ghana Academy of Arts and Sciences, and the Ghana Atomic Energy Commission. It could be argued that this representative board is also a mechanism by which the Fund satisfies the interests of the CSIR.

Tanzania: A science granting council inside the governmental structure that pilots the Fund
The Tanzania Commission for Science and Technology (COSTECH) is a governmental institution under the Ministry of Communication, Science and Technology. The National Fund for the Advancement of Science and Technology is located within the COSTECH. This inter-ministerial fund is channelled through the Ministry of Communication, Science and Technology. It is administered by an inter-ministerial and multi-sectorial committee, which comprises representatives of the relevant ministries (President's Office, Treasury, Planning Commission, Communication), the Bank of Tanzania, the University, the Chamber of Commerce, Agriculture and Industry, and the Director-General of COSTECH. Through representation in the committee, the Government can ensure that COSTECH executes the fund in a manner that meets national interests.

Zambia: A dual management of the Fund under supervision of the science granting council on behalf of the government
In Zambia, the National Science and Technology Council (NSTC) administers the Strategic Research Fund on behalf of the Department of Science and Technology in the Ministry of Education, Science, Vocational Training and Early Education. The mechanism by which the Ministry ensures that the NSTC serves the national interest in the administration of the fund is through dual management. The Fund is managed by two committees: the Technical Committee of the NSTC and the Fund Management Committee of the Ministry.

responsibility to a relatively autonomous body, usually referred to as a National Research/Science Foundation or Council. Although such an SGC receives its funds directly from the government and has to account for it, its autonomy derives from the appointment of a separate Council or Board. This Council or Board establishes structures and procedures to ensure fair, transparent and efficient disbursement of funds to research organisations. An example is the South African National Research Foundation, which is a statutory body with its own council. It receives its funding from Treasury via the Department of Science and Technology (now the 'Department of Science and Innovation') and disburses this money through a wide range of instruments to South African universities on a competitive basis. Mozambique has a similar configuration in that the National Research Foundation is directly responsible to the Ministry of Science and Technology. Other countries with similar arrangements are Senegal, Côte d'Ivoire and Namibia.

In many countries, sector-specific funding agencies exist. In most cases, funding agencies for agriculture and health have developed separately over time, usually reflecting the priority allocated to these common domains. In addition, sector-specific agencies are rooted in inter-departmental rivalries, which led governments to establish different funding councils or foundations for different sectors. An example of this *sector-differentiated model* is in South Africa where three bodies have a statutory responsibility for research funding: the National Research Foundation (see above), the Medical Research Council (reporting to the Department of Health) and the Water Research Commission (reporting to the Department of Water Affairs and Forestry). Another is Burkina Faso where three National Funds report to their respective ministries: Research and Innovation for Development (reporting to the Ministry of Scientific Research and Innovation), Education and Research (reporting to the Ministry of Secondary and Higher Education) and Research in Health (reporting to the Ministry of Health).

A different configuration is the *embedded model*. According to this model, it is typical to have either a sub-department or directorate within a Ministry or Department of Science and Technology or a Funding Programme administered by a Ministry or Department. In this case, the Office is an extension of the government with no clear autonomy or independence from the Ministry or Department in charge. This is seen in particular in French-speaking Northern Africa, where the Fund is rather a disbursing agency than an autonomous body, with some confusion between science council and Fund. Another example of this model is COSTECH in Tanzania (see Box 1). In Namibia and Rwanda, these funding agencies are referred to as Commissions.

Finally, a configuration is where universities receiving funds directly from various sources other than government. These are typically international funders, foundations, development agencies[5] and NGOs,[6] which are not necessarily specialised in research. In practice, we find many variations of configuration. These are hybrid models where diverse funding institutions, national or foreign, public or more and more private, co-exist. Empirically, the study by Mouton et al. (2014) also found cases with very little or no co-ordination or interaction between these separate funding channels, a situation that seems to be closely related to the large array of international funding sources.

The Complex Governance of International Funding

The variety of funding sources is not a new thing. At the beginning of our century, a study of African scientists (Gaillard & Furó Tullberg, 2001) had identified 214 sources of foreign funding supporting research activities in sub-Saharan Africa. The main funding sources, measured in occurrences of projects, were USAID, EU, the French cooperation, and World Health Organization (WHO), followed by International Development Research Centre (IDRC), Food and Agriculture Organization (FAO), Agence universitaire de la Francophonie/Université des réseaux d'expression française (AUPELF/UREF), International Atomic Energy

Agency (IAEA), the World Bank and UNESCO, in other words mainly international organisations or institutions specialised in 'research for development' of the donor countries. Twenty years later, the analysis of actual funders draws a different and complex landscape. For example, Nwaka et al. (2012) derived a list of funders from 119 applications for the selection as Centre of Excellence in health innovation. An analysis of acknowledgements in articles with an affiliation in Niger (1995–2015) indicate sixty-seven different sources of funding, out of which 18% come private funds—with BMG accounting for 9.3% of the mentions (Marou Sama, 2016). A recent study of five Sahel countries (Mauritania, Mali, Burkina Faso, Niger and Chad) and Senegal shows that international collaborations represent 79%–91% of the overall production of articles in the Web of Science (1980–2017) and 72% for Senegal, which has a larger overall production and a larger scientific community. All of these research collaborations are supported by some foreign funder, mainly from France, EU and the United States (Costas et al., 2020). The observation of the current dynamics of international funding reveals the growing importance of private foreign partners in the structuration of research in the continent and the multiplication of large initiatives to combine sources of funding.

Private foundations are dominating the scene, being richer than public funders with defined domains of preference in mainly the areas of health, tropical diseases and epidemics (Head et al., 2017; Nwaka et al., 2012). Large private philanthropic sources provide funds through international bodies such as WHO where donors designate how their contributions are to be spent. As the OECD (2018) notes, Africa was the largest beneficiary region, receiving about a third of the global philanthropic aid, most of which was implemented through intermediary institutions, and:

> while philanthropic giving remains relatively modest compared to ODA [Official Development Assistance] (5% of the three-year total) and financing for development more broadly, foundations have already become major partners in some specific areas. For example, in the health and reproductive health sectors in 2013-2015, foundations support was the third-largest source of financing for developing countries, following that of the United States and the Global Fund to Fight AIDS, Tuberculosis and Malaria [...] The Bill & Melinda Gates Foundation (BMGF) was by far the most significant philanthropic donor, having provided almost half of total giving (49%). In addition, 81% of the total philanthropic giving during 2013-15 was provided by only 20 foundations. (OECD, 2018, p. 16)

The OECD suggests that 'official' donors from the Development Assistance Committee (DAC) could engage more systematically with private foundations. Today, many initiatives are a blend of private and public funding, as for example, the African Biosafety Network of Expertise.

Private funding is changing the very notion of 'agenda setting' (Vessuri, 2017). The old paradigm of scientists defining the areas of research, based on their experience, is mediated by the dynamics of philanthropic bodies. Donors in the past—public institutions in country members of the DAC—defined the agenda as

part of their participation to aid policy. Donors selected the countries they worked with, because of political affinities and colonial past (Gaillard, 1999), as well as because of diplomatic relations with other donors—usually all members of the DAC. Today, in the era of co-construction and multi-agency schemes, few funding agencies would choose to work without engaging in some form of engagement with local authorities. Moreover, 'cost-sharing' is actively promoted by the World Bank and encouraged by the OECD, in public–private partnerships being supposed to be the best way forward. Donors and foreign agencies participate in the design and delivery of instruments, under the assumption that 'co-constructed', 'co-owned', 'co-funded' measures between foreign partners and national policy bodies will have a better chance to create scientific research. This has been particularly the case for EU through its International Cooperation projects.

Another change is that these multi-actors/multi-agency initiatives are producing large initiatives. Programmes aimed at multi-annual support and seeking to produce an impact through concentrated resources have led to the idea of centres of excellence and networking initiatives combining public and private sources of funding. A number of initiatives have been instigated to create research centres, such as the AIMS Centres for Mathematical Sciences, to promote 'clusters of knowledge' that would allow, in a single location, exchange of ideas, profit from common investments and shared agendas. A well-known initiative, the African Centres of Excellence, was launched in 2013 by the World Bank. Topics range from health and environment to fields like materials, oil chemistry, applied mathematics and computer sciences. These Centres have trained around 3,000 faculty personnel inside the Centres and more than 2,500 faculty nationals from African countries.[7] In addition, the West African Economic and Monetary Union designated fourteen centres of excellence. Most of these centres received national and foreign funding, the latter being usually the main source. The process of selecting and approving these centres has been documented in the case of thirty-two centres of excellence in health (Nwaka et al., 2012). These centres of excellence may have differing mandates, but they all participate in training researchers, establishing partnerships with national and foreign universities and businesses, as well as creating synergies at the sub-regional level or promoting management and governance models that are supposed to be models for the partnering universities.

It is important to note also that all these larger initiatives have emerged on the African continent, not only under the auspices of some large (foreign) funder, but as a political effort to create larger African partnerships. The Coalition of African Research and Innovation (CARI) was set up by the African Academy of Sciences (AAS) in partnership with African and global partners.[8] The Alliance for Accelerating Excellence in Science in Africa (AESA) is another major political science funding platform that was launched in 2015, with the support of the AAS and the NEPAD Agency.[9] AESA (2015) was designed to promote the African Union's Science, Technology and Innovation Strategy for Africa (STIS).

Given the low levels of R&D funding by national governments, it is common to dismiss these political efforts. But building a 'Coalition' cannot be attributed

exclusively to some political gesture that is void from any real content. On the contrary, the African Union has shown its willingness to translate into reality a common new discourse on the necessity to 'ensure inclusive participation of all stakeholders' and to create 'a highly coordinated, well-funded, innovative African STI community'. Still, the rhetoric on development and science and technology is based on a 'deficit model'—as signalled by Skupien and Rüffin (2020)—where Africa needs to overcome some of the pervasive deficits. Even without consensus on what are the mains deficits, or who might be held responsible for them, some political engagement seems possible through these large initiatives, and foreign partners are called to participate to building long-term capacity. In other words, we observe 'strategic advocacy' in favour of African science, coming from within Africa, and across the continent.

Many initiatives are creating 'platforms' that gather stakeholders and funding but remain limited to a specific area of expertise. Such is the case of the Lacuna Fund, an effort to create African data sets and an expertise in machine learning, which began as a collaborative action between the Rockefeller Foundation, Google.org and Canada's IDRC. The computer science community has been able to develop despite living in such a strongly 'donor-driven' environment. The case studies by Harsh et al. (2018) show that both researchers and administrators were able to shape academic programmes and training growing numbers of PhDs, creating a professional identity, defining projects using the funding available and gaining a global competency. Dozens of similar platforms could be mentioned in various other areas of knowledge, acting at a regional level, and usually tied to a donor agency, such as USAID, the Consultative Group on International Agricultural Research (CGIAR) or regional actors. These can be found as 'projects' funded by some larger global or regional consortium. These 'projects' or programmes are shaped around policy-relevant issues and, in many cases, allow for private-sector participation. This down to the earth structuring, through a close connection of academics with the funding agencies, is probably the backbone of today's re-institutionalisation of science in Africa.

Foreign funders need to justify their own objectives, and the complexity of the funding scenario is now a matter of intense examination. In a recent report on North–South research partnerships that was commissioned by the UK (now defunct) DFID, J. Dodson selected eleven programmes funded mainly by institutions from the UK, the USA, Sweden, Switzerland, Japan and the Netherlands (Dodson, 2017). Her analysis examines these 'hybrid' models of funding with foreign funding and/or South management and classifies these partnerships by management structures, based on the distribution of partnering roles and the location of the management of the programme, either in Africa or in the foreign country. She tends to assume that foreign funders gradually introduce a more active African management, based upon experience of funding programmes and capacity building. More South-managed multi-agency programmes should appear. She notes that these are 'rare' and offers the DELTAS Programme DELTAS funded by DFID and Wellcome Trust as an example of this trend. The evidence so far seems to contradict the idea of such a 'trend'. Most foreign funders continue to manage their funding, creating ad hoc structures, except in some

rare cases. ASEA seems one of these, since it has the dual benefit of being endorsed by the African governments represented in the African Union and by having a regional experience through the African Academy of Science, which is recognised as such by the foreign counterparts.

An important initiative is the European & Developing Countries Clinical Trials Partnership (EDCTP) concerning research, development and testing of new medicines against HIV/AIDS, malaria and tuberculosis. EDCTP1 has supported 196 research projects, including 57 clinical trials involving more than 100,000 participants. It has also helped train more than 300 African scientists. EDCTP is in phase two since 2014 and is scheduled to receive €2 billion from the European Commission over the next 10 years.[10] Calls for projects are co-funded by participating entities with the European Commission. EDCTP is built on a provision that allows for research to have multi-year programming with multiple countries partnering.[11] Another example is in the Mediterranean region, the PRIMA initiative under a similar regulation that has been created after two programmes using the ERA-NET funding instrument (project ARIMNet in Agriculture and the generic funding programme called ERA-NET MED) (Zebakh et al., 2021). Finally, the EU has launched, December 2020, programme ARISE (African Research Initiative for Scientific Excellence), engaging €25 million funded by DG DEVCO and that will be managed by the AAS (Nairobi). The first call for projects was announced when finishing the writing of this article in February 2021. Similar to the Starting Grants of the European Research Council (ERC), these grants are dedicated to individual scientific excellence in Africa. Grants are geared to young researchers (2–7 years after their PhD) with grants up to €500,000 in all areas of science.[12]

In addition to these initiatives, the usual scholarship programmes (Marie Curie, DAAD, Newton and others) and bilateral cooperation for research and mobility schemes continue. These more traditional initiatives are based on funding individuals. The Newton Fund, created in 2014, has been designated as a successful venture (Grimes & McNulty 2016). It consists of partnerships between the United Kingdom and fifteen middle-income countries in order to provide appropriate frameworks for support and funding. Within universities, various research-related initiatives can be found. In Tanzania, cooperation between the Muhimbili University College of Health and Allied Sciences in Dar es Salaam, the University of Heidelberg (Germany) and GTZ (German cooperation Agency) in the early 2000s led to the introduction of a first master of public health. In South Africa, achievements regarding the transformation of higher education were accomplished through the South Africa Norway Tertiary Education Development Programme (NUFFIC). Starting in 2000, it aimed at improving access and success of previously disadvantaged students, enhancing the administrative and academic capacity of selected universities and facilitating regional cooperation. When the programme formally ended in 2010, it had—despite a comparatively small amount of foreign investment—catalysed structural changes and institutional linkages spanning sixteen universities in South Africa and the Southern African Development Community region (Gibbon, 2014). In French-speaking countries, Hubert Curien Programmes are co-managed bilaterally by a French and a

national committee of the partnering country.[13] These programmes are particularly active in the Mediterranean region as well as in Africa and Latin America, and now Asia—over 2,000 projects every year.

Conclusion: Structural Effects of Funding

The changes in the political economy of science in Africa have had structural effects. First on the necessary relation with national institutions. As the legitimate owners of policy in their respective countries, national institutions are the 'natural' partners for donors. In some cases, donors provide support in creating policy-making institutions. This was the case of the Millennium Science Initiative in Uganda (World Bank report by Blom et al., 2016), where donors financed approximately 30% of the government's budget. With its newly reformed Ministry of Education, Science, Technology and Sports, the country received funds for research grants, enhancing education programmes and creating linkages between academia and industry. Uganda and Tanzania stand out as preferred investment countries for research development funds. These investments are mainly in the health sector (Head et al., 2017) and development activities (Hunsmann, 2016; Koch & Weingart 2016). The massive focus on health—a result of the Global Health initiatives—is also a consequence of these funding activities, to the detriment of other scientific areas, mainly in the basic sciences (Blom et al., 2016; Chataway et al., 2019; Pouris & Ho, 2013).

A second consequence relates to issues of governance arising from multilateral arrangements. While it is not possible for a foreign agency to define the agenda alone anymore, a foreign funding agency can choose to manage specific funding schemes, or find solutions allowing them to keep some control over the disbursement of funds even though national participation has to be taken into account. Such hybrid management practices become the norm, but large programmes with multiple foreign sources of funding and some local institution, where a national authority participates only as one among others, and not steering the system, pose governance issues. Today, accountability is still stronger on the side of the funders, which also explains that there are very few exceptions where the funder delegates power to the universities or units participating in the projects. Some cases of corruption have shed doubts on the necessary control of external funding and obliged to create adequate tools to this end.[14] Moreover, management through its measurements and analysis instruments is de facto imposing a dominant position to who manages the metrics and instruments used in evaluating investments and outcomes (Cabane & Tantchou, 2016). Finally, it should be remembered that some large funding agencies tend to use financial indicators such a disbursement as a management guidance. Obviously, this does not take into account specific organisational limitations or issues concerning the difficulty to hire personnel.

Although foreign funders cannot avoid being embedded in cooperation with granting councils, the latter representing of local political forces and interests, the foreign agencies tend to dominate these complex alliances. A series of procedures and efforts within partnerships address the possible 'unequal power dynamics' (Dodson, 2017) such as awarding letters sent to all grantees underlining that funding

resulted from joint bid, site visits from the funders to localities where funding is used, intensive communication with project coordinators, creation of a specific financial management capacity and so on. All these practices are linked to individual participations. Less is known about the effects at the systemic level. For example, we have only anecdotal evidence, and too few studies, on the way funding is affecting the careers within academia. Funding is also encouraging partnerships among universities and foreign institutions. The growing complexity of the funding landscape should not conceal the fundamental role played by universities. The power engine of the knowledge economy is universities,[15] and African universities are definitely, albeit at different levels, on a growing track, adopting quality criteria and promoting research, as well as an international policy which includes effective partnership agreements (Cloete et al., 2011, 2015). Universities also are 'safe spaces' for diasporic scientists developing 'transnational higher education partnerships' with African universities (Dia & Ngwe, 2018; Obamba, 2013). In French-speaking Africa, after many years of little or no effort, a harmonisation of quality is taking place under the auspices of CAMES (Cissé, 2018). Funding has been actively used by University administrators to enhance research and teaching throughout the continent.

Research in Africa continues to rely heavily on foreign funding coming from a large variety of funders, each with their own agendas and objectives. Many of these funders proclaim that their interests coincide with 'national priorities' of their African partners, or at least the 'needs' of African populations. That these 'priorities' and 'needs' are not always expressed clearly by African authorities is a concern in terms of neo-colonial modes of functioning through international collaborations. This lack of influence on the research agenda defines a *non-hegemonic position in the World science system* (Losego & Arvanitis, 2008). Nonetheless, the more recent developments show that there is a growing awareness that African countries should prioritise and define strategic areas for funding. This incipient effort needs to be documented as the proliferation of funding deeply transforms universities and research systems (Arvanitis & O'Brien, 2019).

DECLARATION OF CONFLICTING INTERESTS

The authors declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

FUNDING

The authors received no financial support for the research, authorship and/or publication of this article.

NOTES

1. The French Institute of Research for Development (IRD) has designed indicators based on *Web of Science* for major African countries that confirm this trend. See http://www.beep.ird.fr/cop/cop_liste.php
2. It is important to point out that these counts are based on full paper counts at the country level. Using a fractional counting method produces lower figure (which is an indirect measure of the

fact that authors from African countries are usually in the minority on most co-authored papers with the rest of the world). However, the trend is the same with a near doubling in world share from 1.3% in 2000 to 2.2% in 2018.

3. The table reflects the most recent data for Africa as sourced from the Third *African Innovation Outlook* (NEPAD, 2019) and the most recently available data on the UNESCO Institute of Statistics website. In both cases, however, with the exception of South Africa, Ethiopia and Ghana, no data since 2017 are available for the remaining countries.
4. Over this 12-year period, UNCST gave a total of US$1,245,898 directly and also US$2,134,453 through the Millennium Science Initiative (MSI), a programme funded mainly by/through the World Bank and IEG (2016).
5. AFD (France), EU, SIDA (Sweden), Wellcome (the United Kingdom), GIZ (Germany), Danida (Denmark), NORAD (Norway), DFID (the United Kingdom), Australia AID, USAID, DAAD (Germany), Carnegie Corporation of New York, Ford Foundation, Rockefeller Foundation, Bill & Melinda Gates, PEPFAR, World Bank and many others.
6. A most striking example is in Tanzania the Health and Care for Mother and Child, which is entirely outsources to a UK-based NGO (Hunsmann, 2016).
7. See World Bank data: http://projects.worldbank.org/P126974/strengthening-tertiary-education-africa-through-africa-centers-excellence?lang=en&tab=overview
8. See https://www.aasciences.africa/cari
9. Chemistry International—The News Magazine of IUPAC, May 2015, *37*(3), 20–21.
10. See http://ec.europa.eu/research/iscp/index.cfm?pg=africa
11. Appearing in article 185 of the European Union Treaty concerning the participation of various countries in a pluriannual research programme. Programmes funded by the EU under this regulation are known as ‘Article 185 initiatives’.
12. See https://www.aasciences.africa/call/arise
13. See https://www.diplomatie.gouv.fr/en/french-foreign-policy/scientific-diplomacy/scientific-partnerships/
14. See https://scienceafrica.co.ke/new-tool-to-help-curb-corruption-in-donor-funded-projects/
15. Numerous studies from authors such as M. Castells, J. Ziman, or N. Stehr offer social and historical evidence. The metaphor of the ‘triple helix’ (Leydesdorff and Etzkowitz)—wider than that of the ‘entrepreneurial university’ (proposed by Etzkowitz)—situates the contribution of the university into a complex relational web of research and economy.

REFERENCES

African Leaders Endorse a Science Funding Platform for Africa: the Alliance for Accelerating Excellence in Science in Africa. (AESA). (2015). *Chemistry International, 37*(3), 20–21. https://doi.org/10.1515/ci-2015-0307

Arvanitis, R., & O’Brien (Eds.). (2019). *The transformation of research in the South: Policies and outcomes*. IDRC & IRD/Editions des Archives Contemporaines.

Arvanitis, R., Waast, R., & Gaillard, J. (2000). Science in Africa: A bibliometric panorama using PASCAL database. *Scientometrics*, *47*(3), 457–473.

Blom, A., Lan, G., & Adil, M. (2016). *Sub-Saharan African science, technology, engineering & mathematics research. A decade of development*. Elsevier & World Bank.

Cabane, L., & Tantchou, J. (2016). Measurement instruments and policies in Africa. *Revue d’anthropologie des connaissances*, *10*(2), 127–145.

Chataway, J., Dobson, C., Daniels, C., Byrne, R., Hanlin, R., & Tigabu, A. (2019) Science granting councils in Sub-Saharan Africa: Trends and tensions. *Science and Public Policy*, *46*(4), 620–631. https://doi.org/10.1093/scipol/scz007

Cissé, C. (2018). *La CAMES 1968–2018. Un demi-siècle au service de l’enseignement supérieur et la recherche en Afrique [CAMES 1968–2018. Half a century of service to higher education and research in Africa]*. Science et bien commun.

Cloete, N., Bailey, T., Pillay, P., Bunting, I., & Maassen, P. (Eds.). (2011). *Universities and economic development in Africa: Key findings*. African Minds.

Cloete, N., Sheppard, C., & Bailey, T. (2015). South Africa as a PhD hub in Africa? In N. Cloete, P. Maassen, & T. Bailey (Eds.), *Knowledge production and contradictory functions in African higher education* (pp. 75–108). African Minds.

Confraria, H. (2014). The impact of African science: A bibliometric analysis. *Scientometrics*, *10*(2), 1241–1268.

Costas, R., des Bordes, C. & van Wijk, E. (2020). *Bibliometric analysis of the Sahel region* (Report for the SAFIRE project). CWTS, University of Leiden, 33 pp.

CREST. (2020). *Bibliometric analyses of African bibliometric indicators* (Internal report). CREST.

Currie-Alder, B., Arvanitis, R., & Hanafi, S. (2018). Research in Arabic-speaking countries: Funding competitions, international collaboration, and career incentives. *Science and Public Policy*, *45*(1), 74–82.

Dia, H., & Ngwe, L. (2018). The movement of African teachers and researchers: Controversies, practices and policies. *Revue d'anthropologie des connaissances*, *12*(4), 539–551.

Dodson, J. (2017). *Building partnerships of equals. The role of funders in equitable and effective international development* (Report by UK Collaborative on Development Science). UK Collaborative on Development Science.

El-Kenz, A. (1997). Prometheus and hermes. In T. Shinn, J. Spaapen, & V. V. Krishna (Eds.), *Science and technology in a developing world* (pp. 323–348). Kluwer.

Gaillard J., & Waast, R. (1988). La recherche scientifique en Afrique [Scientific research in Africa]. *Afrique Contemporaine*, *148*, 3–29.

Gaillard, J. (1999). *La coopération scientifique et technique avec les pays du sud. Peut-on partager la science? [Scientific and technical cooperation with the countries of the South. Can science be shared?]* Karthala.

Gaillard, J., & Furó Tullberg, A. (2001). *Questionnaire survey of African Scientists*. http://www.ifs.se/Publications/Mesia/mesia.asp

Gibbon, T. (Ed.). (2014). *The story of the South Africa Norway Tertiary Education Development Programme*. African Minds.

Grimes, R. W., & McNulty, C. (2016). The Newton fund: Science and innovation for development and diplomacy. *Science & Diplomacy*, *5*(4). https://www.sciencediplomacy.org/sites/default/files/the_newton_fund_0.pdf

Hanafi, S., & Arvanitis, R. (2016). *Knowledge production in the Arab World: The impossible promise*. Routledge.

Harsh, M., Bal, R., Wetmore, J., Zachary, G., & Holden, K. (2018). The rise of computing research in East Africa: The relationship between funding, capacity and research community in a nascent field. *Minerva*, *56*(1), 35–58.

Head, M. G., Goss, S., Gelister, Y., Alegana, V., Brown, R. J., Clarke, S. C., Fitchett, J. R. A., Atun, R., Scott, J. A. G., Newell, M.-L., Padmadas, S. S., & Tatem, A. J. (2017). Global funding trends for malaria research in sub-Saharan Africa: A systematic analysis. *The Lancet Global Health, 5*(8), e772–e781.

Hunsmann, M. (2016). Le 'plaidoyer fondé sur des preuves' dans l'action sanitaire internationale. Vers un nouveau type d'ingénierie sociale? ['Evidence-based advocacy' in international health action. Towards a new kind of social engineering?] *Revue d'anthropologie des connaissances*, *10*(2), 219–243.

Hydén, G. (2017). The role and impact of funding agencies on higher education and research for development. In T. Halvorsen, & J. Nossum (Eds.), *North-South knowledge networks: Towards equitable collaboration between academics, donors and universities* (pp. 1–40). African Minds.

Koch, S., & Weingart, P. (2016). *The delusion of knowledge transfer: The impact of foreign aid experts on policy-making in South Africa and Tanzania*. African Minds.

Losego, Ph., & Arvanitis, R. (2008). La science dans les pays non-hégémoniques [Science in non-hegemonic countries]. *Revue d'Anthropologie des Connaissances*, *2*(3), 343–350.

Marou Sama, K. (2016). *Les carrières des chercheurs et les politiques d'enseignement supérieur et de recherche au Niger [Research careers and higher education and research policies in Niger]* (Doctorat). UPEM.

Mouton, J. (2008). Africa's science decline: The challenge of building scientific institutions. *Harvard International Review*, *30*(3), 46–51.

Mouton, J., Basson, I., Blanckenberg, J., Boshoff, N., Prozesky, H., Redelinghuys, H., Treptow, R., van Lill, M., & van Niekerk, M. (2019). *The state of the South African research enterprise*. http://www0.sun.ac.za/crest/wp-content/uploads/2019/08/state-of-the-South-African-research-enterprise.pdf

Mouton, J., & Boshoff, N. (2010). Bibliometric analysis of scientific output (of Africa). In NEPAD (Ed.), *African innovation outlook 2010* (pp. 86–134). NEPAD.

Mouton, J., Gaillard, J., & van Lill, M. (2014). *Science granting councils in Sub-Saharan Africa* (Report to IDRC). CREST.

Narváez-Berthelemot, N., Russell, J. M., Arvanitis, R., Waast, R., & Gaillard, J. (2002). Science in Africa: A bibliometric approach. *Scientometrics*, *54*(1–2), 229–241.

NEPAD. (2014). *African innovation outlook 2014*. NEPAD.

NEPAD. (2019). *African innovation outlook 2019*. NEPAD.

Nwaka, S., Ochem, A., Besson, D., Ramirez, B., Fakorede, F., Botros, S., Inyang, U., Mgone, C., Adae-Mensah, I., Konde, V., Nyasse, B., Okole, B., Guantai, A., Loots, G., Atadja, P., Ndumbe, P., & Sanou, I. (2012). Analysis of pan-African centres of excellence in health innovation highlights opportunities and challenges for local innovation and financing in the continent. *BMC International Health and Human Rights*, *12*(1), 1–15.

Obamba, M. O. (2013). Transnational knowledge partnerships: New calculus and politics in Africa's development. *Compare: A Journal of Comparative and International Education*, *43*(1), 124–145.

OECD. (2018). *Private philanthropy for development*. OECD Publishing.

Pouris, A., & Ho, Y.-S. (2013). Research emphasis and collaboration in Africa. *Scientometrics*, *98*(3), 2169–2184.

Psacharopoulos, G., Tan, J., & Jimenez, E. (1986). *The financing of education in developing countries: Exploration of policy options*. The World Bank.

Skupien, S., & Rüffin N. (2019). The geography of research funding: Semantics and beyond. *Journal of Studies in International Education*, *24*(1), 24–38.

Tijssen, R. J. W. (2007). Africa's contribution to the worldwide research literature: New analytical perspectives, trends, and performance indicators. *Scientometrics*, *71*(2), 303–327.

UNESCO. (2015). *World science report. Toward 2030*. UNESCO.

UNESCO Institute for Statistics. (2019). *Statistics on science, technology and innovation*. http://uis.unesco.org/en/topic/research-and-development

Vessuri, H. (2017). From science as 'development assistance' to 'global philanthropy'. In D. Tyfield, R. Lave, S. Randalls, & C. Thorpe (Eds.), *The Routledge handbook of the political economy of science* (pp. 405–415). Routledge.

Waast, R. (2006). Savoir et société: un nouveau pacte à sceller [Knowledge and society: a new pact to seal]. In E. Gérard (Ed.), *Savoirs, insertion et globalisation. Vu du Maghreb* (pp. 373–403). Publisud.

Waast, R., & Gaillard, J. (2001). *L'état des sciences en Afrique* [The State of Science in Africa] (Report of IRD). http://www.ird.fr/la-mediatheque/archives-et-bases-de-donnees/dossiers/l-etat-des-sciences-en-afrique

World Bank. (2014). *A decade of development in Sub-Saharan African science, technology, engineering & mathematics research*. Elsevier & The World Bank.

World Bank, & IEG (Susan Ann Caceres). (2016). *Project performance assessment report.* Uganda Millennium Science Initiative (IDA CREDIT No. 41740). IDA.

Zebakh, S., Rhouma, A.Arvanitis, R., & Sadiki, M. (2022). Mapping the agricultural research systems in the Maghreb (Algeria, Morocco, and Tunisia). *Science, Technology & Society.* https://doi.org/10.1177/09717218221078231