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Centre Population
et Développement

WORKING **PAPER**

43

Observing and Funding African Research

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Observing and Funding African Research

Rigas Arvanitis^a & Johann Mouton^b

Abstract

This document presents an overview of (recent) historical as well as current trends in scientific production in Africa. This review clearly shows that there has been a reversal of trends in scientific production that started around the turn of the millennium. Whereas African science was on the decline during the last two decades of the previous millennium, there is now abundant evidence that scientific output is increasing, that Africa's share of world scientific papers has grown significantly and that international research collaboration has increased substantially. These changes are occurring at the same time as international funding of research in Africa is increasing - especially in the fields of health, environmental sciences and some aspects of agricultural sciences. Our analysis of these trends, however, also shows that there remain areas of concern and challenge, viz. the low investment by African governments themselves in (public) Research and Development (R&D) and thus the continued reliance by many countries and universities on foreign funding.

We highlight some of the structural effects the various new funding arrangements have had on scientific research in Africa. We point to three already visible effects: (1) the absolute need to involve national institutions in any new funding landscape; (2) the effects on governance arrangements amidst the increasing complexity of multi-lateral, multi-actor funding frameworks; and (3) the yet largely unknown effects that funding configurations may have on the careers of scientists (especially young scientists) on the continent.

We then discuss three structural constraints of research in Africa: (1) the essential role of universities as the main loci for research in Africa; (2) the challenge about investing in research activities in order to promote excellent research; (3) the priority to address the challenges related to employment and the circulation of scientists (in the wake of decades of emigrations of scientists and highly skilled workers).

We conclude with a summary overview of the political economy of research in Africa today. We remind the reader of the positive trends in the 'rise' of African science, but at the same time make some cautionary notes about the remaining challenges.

INTRODUCTION

Although some serious academic research has been conducted on the dynamics and trends in African research systems since at least the early eighties, there is still a long way if we want to satisfy Kofi Annan's claim at the Higher Education Summit, Dakar, March 2015: "We need empirically-based, data-informed decision-making in Africa in order to improve governance and productivity". Systematic efforts to collect and

analyse data on research in Africa have been led by very few research teams such as in South Africa (SciSTIP)¹ or in France (CEPED unit)². "*Science in Africa*" coordinated by R. Waast and J. Gaillard in 1998-2000 was the first European study to produce a pan-African overview of African research systems³ (Waast & Gaillard, 2001). Before this project, most studies were restricted to scientometric and policy analyses.

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¹ In particular, the Centre for Research on Evaluation, Science and Technology (CREST), now part of the consortium SciSTIP, DST-NDR Centre of Excellence in Scientometrics and Science, Technology, and Innovation Policy. <http://www0.sun.ac.za/crest/>

² Research Team on Science and Education, IRD-CEPED, Paris, formerly known as "Savoir et Développement", now "Education, Science, and Knowledge". <http://www.ceped.org/en/research-teams/article/team-3-family-and-education>.

³ South Africa, Egypt, Tunisia, Algeria, Morocco, Senegal, Burkina Faso, Côte d'Ivoire, Cameroon, Madagascar, Nigeria, Kenya, Tanzania, Zimbabwe, Mozambique.

PREAMBLE: A FEW WORDS ON EXISTING DATA SOURCES

Science, technology, and higher education has received increasing attention in Africa with a concomitant increase in the number of studies.⁴ Nonetheless, there is still a dearth of social analyses of higher education or science and technology when compared to Latin America (in particular Brazil, Argentina, Mexico, Peru, Colombia) and Asia (India, China, Taiwan, Singapore).

One effort to fill this gap occurred in 2006 when CREST (Centre for Research on Evaluation, Science and Technology) and IRD (French Institute for Development Research) teams joined forces in 2006 to produce a large meta-study on 55 middle-income countries (Mouton & Waast, 2008) which provided an overview of a variety of factors that affect the STI policies as well as their social embeddedness. This large study has generated some important clues on the way science works under adverse social, political and economic conditions in Latin America, Asia and Africa. Another important initiative to improve data on African science system, under the auspices of New Partnership for Africa's Development (NEPAD), has been the African Science and Technology Innovation Indicators Initiative (ASTII). This initiative informed a regional report titled the *African Innovation Outlook* (2010), concerning 19 countries, followed by a 2014 edition including 35 countries in the analysis (NEPAD, 2014).

SciSTIP continues to monitor the scientific production on the African continent.

African research production has been the subject of a number of bibliometric studies, since the first systematic use of a multidisciplinary database (the French defunct PASCAL) (Arvanitis, Waast, & Gaillard, 2000), followed by a first study using the SCI (Science Citation Index today known as Web of science) (Narváez-Berthelemot, Russell, Arvanitis, Waast, & Gaillard, 2002) that was done for the "*Science in Africa*" project at IRD. This early work showed a rather elusive research activity, and an uncertain institutional environment. Later, a comprehensive analysis based on SCI by Robert Tijssen (2007) at the University of Leiden Centre for Science and Technology Studies showed that sub-Saharan Africa had fallen dramatically behind in its share of world science production. More recent work done by CREST for the African Innovation Report 2010 (Mouton & Boshoff, 2010), or a report commissioned by the World Bank (2014) to Elsevier on the Scopus database has shown a growth of the production. Other researchers have produced similar studies (Confraria, 2014; Pouris & Ho, 2013) and the last *World Science Report* of UNESCO (2015) confirms the data as reported by the Web of Science. For the needs of this Working Paper, we use our own analysis of the data.⁵

THE DECLINE OF UNIVERSITY RESEARCH IN AFRICA IN THE LATE 1990S AND EARLY MILLENNIUM

Various international forces associated with globalization and internationalization of trade in the 1980s and 1990s had a devastating effect on the economies of many African countries: the decline in export volumes as well as the relative

decline in the price of primary products in world trade, combined with the mishandling of exchange rates and of external reserves, and the huge external overhanging debt created together major resource gaps for the countries of Africa. This put

⁴ And need to be consolidated. One such intent is the South African consortium SciSTIP leadered by CREST at Stellenbosch University, includes many other specialists in the field. A special mention should be made of an eight-year project (HERANA) studying the diversification of research universities in Africa. Other specialists in Africa are working on Universities such as Dantew Teferra, scholar from Ethiopia and now professor at University of Kwazulu-Natal, in Durban, South Africa, and Paul Seleza in Kenya, among others.

⁵ Interactive data visible on-line: production in the Web of science of the main science producers in Africa. Accessible at http://www.beep.ird.fr/cop/cop_liste.php A general graphic shows all the countries. The user can select a specific country from the legend of the general graphic and add or eliminate a country. Data concern overall production, evolution of co-publications and main co-publishing partner country. Analysis and design by Pier Luigi Rossi, IRD, Bondy.

serious pressure on their import capacity and the availability of resources for essential economic and social investment. The result was an increased dependence of the typical sub-Saharan African country on aid from the developed countries.

At the same time international agencies, most notably the World Bank, decided to privilege expenditure on basic education at the expense of support for higher education (Psacharopoulos, Tan, & Jimenez, 1986). This policy position was based on two premises. The first was the belief that the return on investment in primary and secondary education are higher than those in higher education. The second reason related to concerns with equity and access to basic education which would naturally lead to an emphasis on primary education. The result was quite predictable with many universities thrown into financial crisis, laboratories and libraries not receiving any maintenance, overcrowded lecture rooms and huge flight of the top academics from these institutions.

Research and scholarship would be one of the main losers during these years. Africa's share of world science, as measured in papers published in the citation indexes of the Web of Science declined steadily over this period. Sub-Saharan Africa's share of world scientific papers declined from one percent in 1987 to 0.7 percent 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 percent of its share in global science since its peak in 1987; sub-Saharan science had lost almost a third (31 percent). The countries in Northern Africa, 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 (Mouton & Boshoff, 2010).

Numerous case studies covering the period between 1990 and 2005 demonstrated quite convincingly that research at former well-resourced institutions such as Makerere University in Uganda, University of 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 equipment⁶. The cumulative effect of the funding policies of the last two decades of the previous millennium, the huge growth in student enrolments in higher education institutions, combined with continuing political instability in many African countries created a state of affairs which Johann Mouton (2008) described as the "de-institutionalization" of science.

THE DE-INSTITUTIONALIZATION OF RESEARCH INSTITUTIONS IN AFRICA

In a modern science system there are typically a multitude of scientific institutions that perform clearly articulated functions and roles, and together constitute what could be termed the "national mode of scientific production" (Waast & Krishna, 2003). The "national mode" means that science is conducted for the public good and that the direction of science is shaped and steered by the nation's most pressing socio-economic needs. It also implies that the State accepts that it has a major responsibility for financing research and

development activities (Jacques Gaillard, Hassan, Waast, & Schaffer, 2002; Jacques Gaillard, Krishna, & Waast, 1997).

Historically, in the developing world, this regime of knowledge production was initiated after the independences, under a general paradigm of the developmentalist state, and very much linked to the way the states themselves managed national

⁶ The World Bank strategy in Africa had the effect of de-linking universities from development. In addition, it led to development policies that had negative consequences for African nations and their sustainable development potential. Neglect of higher education led to the disestablishment of research centres, medical schools,

agricultural centres, telecommunication and technological development, business training centres, vocational schools and other areas in the higher education sector, which are critical to the development of African societies and their economies. (Cloete, Bailey, Pillay, Bunting, & Maassen, 2011, p.7)

affairs.⁷ Many of the practices in managing resources adopted in the colonial periods, namely the management of society and natural resources as objects of colonial rule without active participation of the various social groups, were persistent throughout the post-independence days (Bonneuil, 2000) and still are in some medical practices (Vinh-Kim, 2010).

The long (debt) crisis period before the new Millennium made the acceptance of knowledge production even more difficult, as well as it evidenced the fragility of the academic work and lack of confidence not only by authoritarian governments (El-Kenz, 1997; Hanafi & Arvanitis, 2016), but also by societies themselves; it created a weak “social inscription of science”, a concept suggested by Roland Waast (2006). Science needs to be embedded in a close relation to the elites of a country, but also in relation to social groups that can express their need for scientific knowledge. This “social contract”, or its absence, explains well the

differences that exist among middle-income countries as far as research policy and efforts to develop their capacities are concerned (Mouton & Waast, 2009).

At the time of these studies, it was concluded that few or none of the features of modern science systems applied to most countries in sub-Saharan Africa. Scientific institutions in these countries remained fragile and susceptible to the vagaries of political and military upheavals. They were severely under-resourced and suffered because of a lack of clarity and articulation of science governance issues (demonstrated by constant shifts in ministerial responsibility for science). These systems were hugely dependent on international funding for R&D, the dominant mode of research was individualistic in nature rather than aimed at building institutional capacities and there was an inadequate reproduction of the scientific and academic workforce.

REVERSING THE TREND IN THE NEW MILLENNIUM

More recent studies (Mouton & Boshoff, 2010; World Bank et al., 2014) show that the tide has turned and that scientific production in Africa has begun to increase substantially since the turn of the century. The annual output of scientific papers has been steadily increasing over the past decade, from 15,285 in 2005 to 54,069 in 2016⁸ (Figure 1). Perhaps most striking is that this rate of increase has surpassed the world growth rates over the same period, with the result that Africa’s share of world publication output nearly doubled from 1.5% in 2005 to 3.2% in 2016. With a smaller portion of the world literature (usually labelled

“mainstream science”), we can examine the rapid growth of the participation of Africa in the World production (Figure 2).

Looking at these longer data series since 1988, we can better visualise the spectacular growth of the world share since 2003-2005 (Figure 3). It also shows that the dynamism of the continent is very much related to the growth of North-African countries (in particular Tunisia, Algeria and Egypt).

⁷ The connection of the science policy to the general development of the state and society is well analysed historically under the concept of regimes of knowledge production proposed by Dominique Pestre (2003). For Europe and the USA, see the *History of sciences and*

knowledge (in French), edited by the same historian (Pestre, 2015).

⁸ Accessible at http://www.beep.ird.fr/cop/cop_liste.php See note 5, above.

Figure 1: Increase in Africa's scientific articles and reviews (2005 – 2016) (Source: ^{CA} Web of Science – all collections)

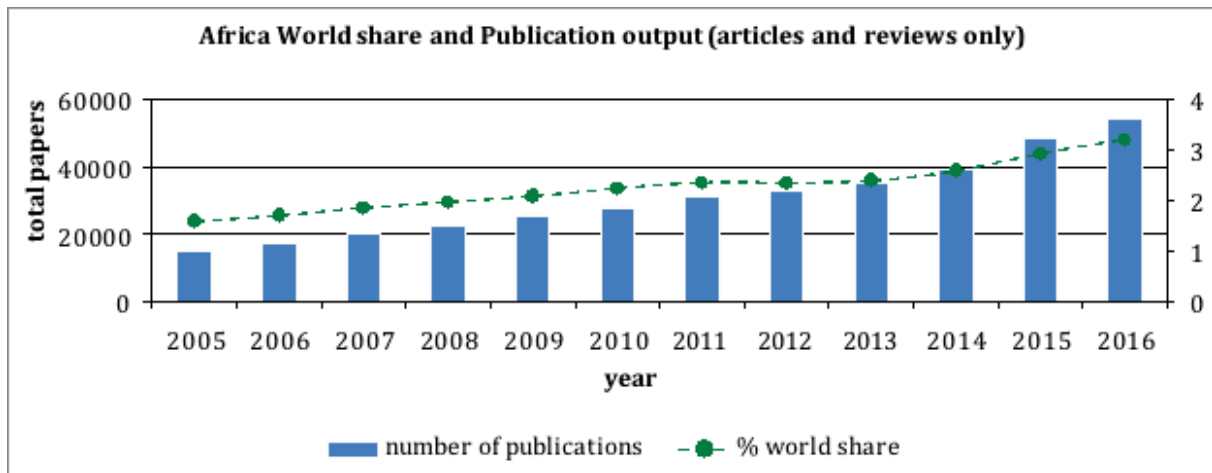


Figure 2: Increase in Africa's scientific total production in mainstream collection (1988 – 2017) (Source: Web of Science - SCI Expanded)

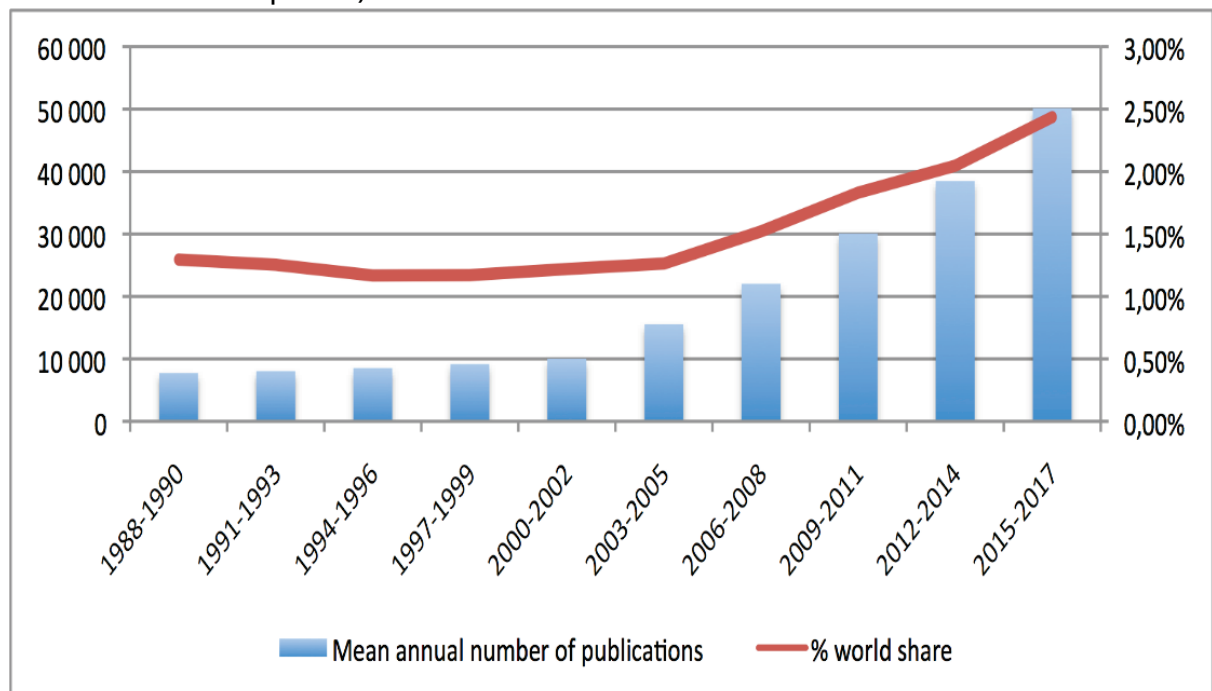
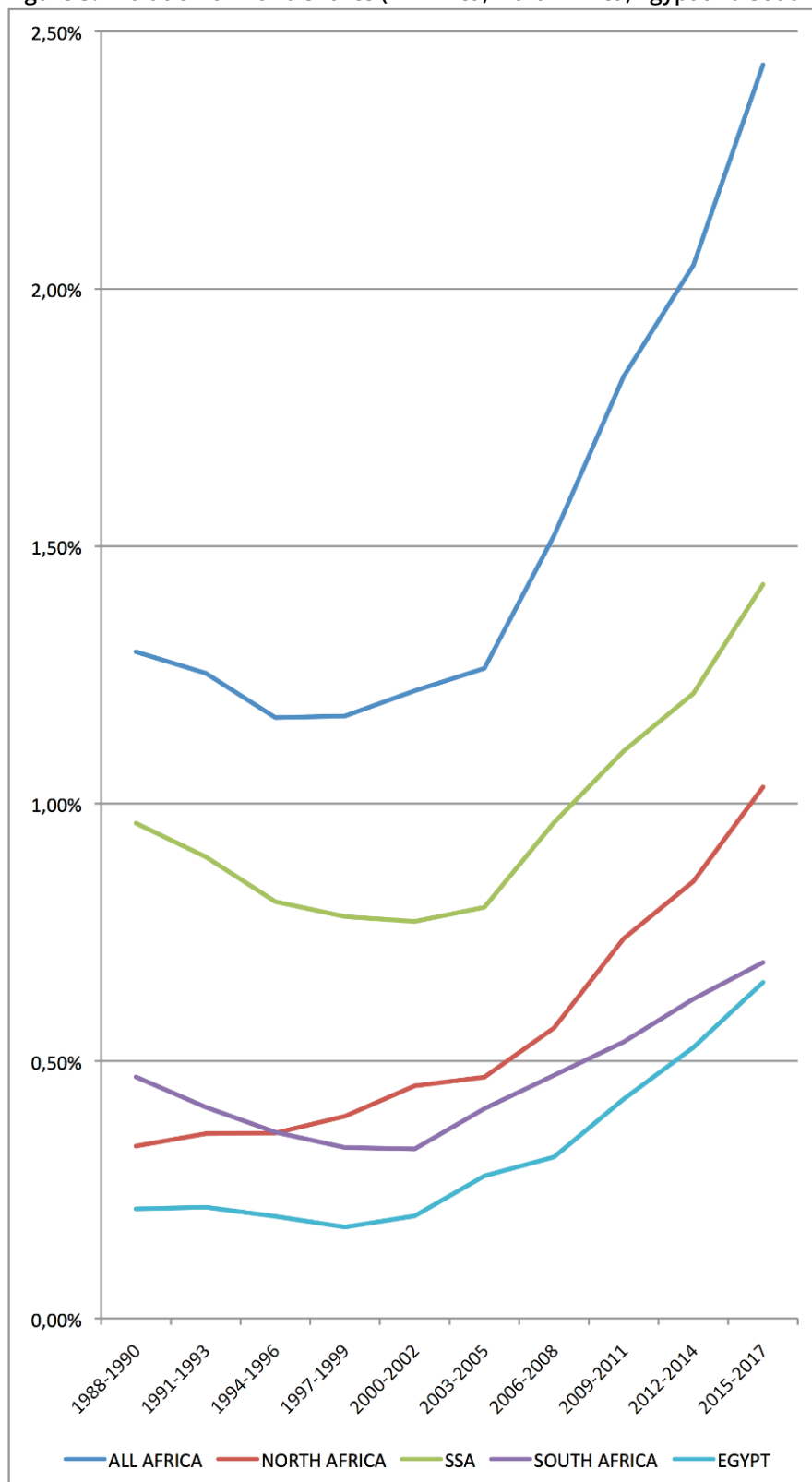


Figure 3: Evolution of world shares (All Africa, North Africa, Egypt and South Africa)



Source: Web of Science – SCI Expanded, not including Social Science Index or Arts and Humanities Index – on-line series.

Note: This subset from the Web of Science with a nearly constant set of journals allows for long-term comparisons. Data on the overall participation of African production is closer to 3,2% of World production in the Web of Science (articles and reviews).

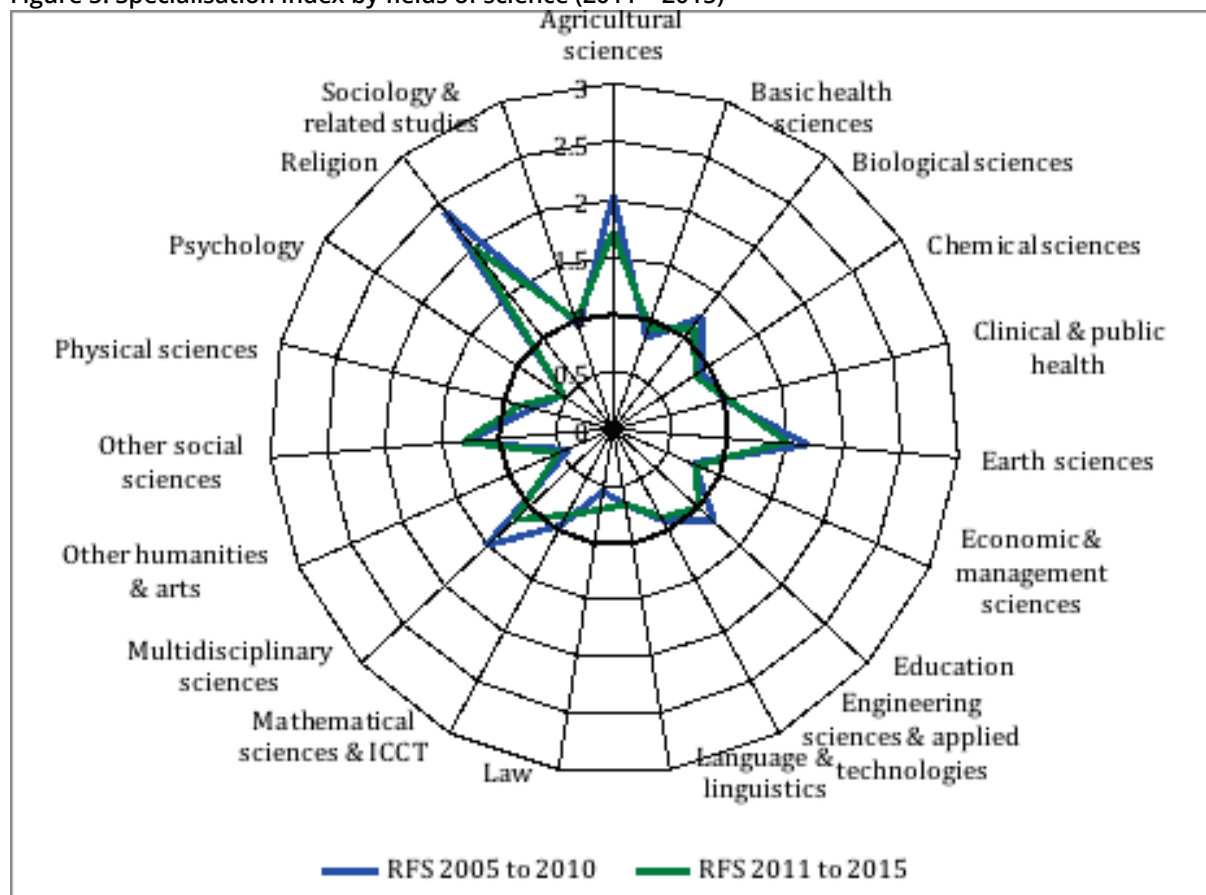
WHICH FIELDS OF RESEARCH?

Out of the total of 273 scientific field categories in the Web of Science, Africa's production is higher than the overall average (2.8%) in 86 fields. If one focuses on those fields which are both large in volume (more than 5 000 papers produced between 2005 and 2015), as well as contributing significantly to world output in those fields (all contributing more than 3% of world production), nine fields meet this criterion: **Tropical medicine; Parasitology; Infectious diseases; Public, environmental and occupational**

health; Water resources; Ecology; Immunology; Zoology and Plant sciences.

These results reaffirm the fact that scientific production often mirrors the material reality of a country or region: in this case, the biodiversity on the continent, as well as the imperative to invest much effort in studying the (tropical) and other diseases that plague many African countries. It also reveals the permanence of the colonial heritage: tropical medicine is a very strong domain in the UK and France, two major contributors to the co-authorship in African countries.

Figure 5: Specialisation index by fields of science (2011 – 2015)



Africa's relative field strength (RFS⁹) is in the Natural and Agricultural sciences: the only broad domains where the RFS Index value is above one. Africa is weakest in the broad domain of the Humanities.

The disaggregation of the **Agricultural** broad area shows that Africa is relatively strong in the field of Agricultural Economics and Policy (where it has increased its standing in the most recent period). Africa is also relatively strong in Agronomy, Plant Sciences and Food Science and Technology – although its position in all three has weakened over time. Africa is not strong in Agricultural Engineering nor in Dairy and Animal science.

In the broad area of **Health** sciences, it is clear that Africa is particularly active and strong in Parasitology (a strength that has been sustained over the past ten years). Its relative activity in Andrology and Virology has also improved.

The disaggregation of the broad field of **Biological Sciences** shows that Africa is particularly active and strong in Entomology and Ornithology and to a lesser extent in Zoology, Biotechnology

and Applied Sciences and Microbiology. However, in all of these fields, Africa has lost some ground in the more recent years.

The disaggregation of the broad field of **Physical Sciences** shows that Africa is relatively strong in three related fields (Astronomy and Astrophysics; Particle Physics and Nuclear Physics).

The disaggregation of the broad field of **Earth Sciences** shows that Africa is relatively strong across all sub-fields. Having said this, Africa has lost some ground in the most recent period in the fields of Water resources, Ecology and Mineralogy. It remains strong in Geology.

As far as the Social sciences and Humanities are concerned, the picture is less positive. Domains belonging to basic sciences, also useful in industry (industrial engineering, material sciences, biotechnological processes, computer sciences) are rather neglected. The agenda, if we read it through the lens of publication outputs, is certainly reflecting the views of the hegemonic partners of Africa — those precise domains where North-South partnerships are dominant.

ADVANTAGES AND CAVEATS ABOUT RESEARCH COLLABORATIONS

African scientists increasingly collaborate with scientists elsewhere.¹⁰ Our analyses show that collaboration between countries on the continent is negligible. In addition, less than 10% of papers are single institution (no collaboration) papers. The vast majority of Africa's papers fall into two categories: papers where the authors co-publish

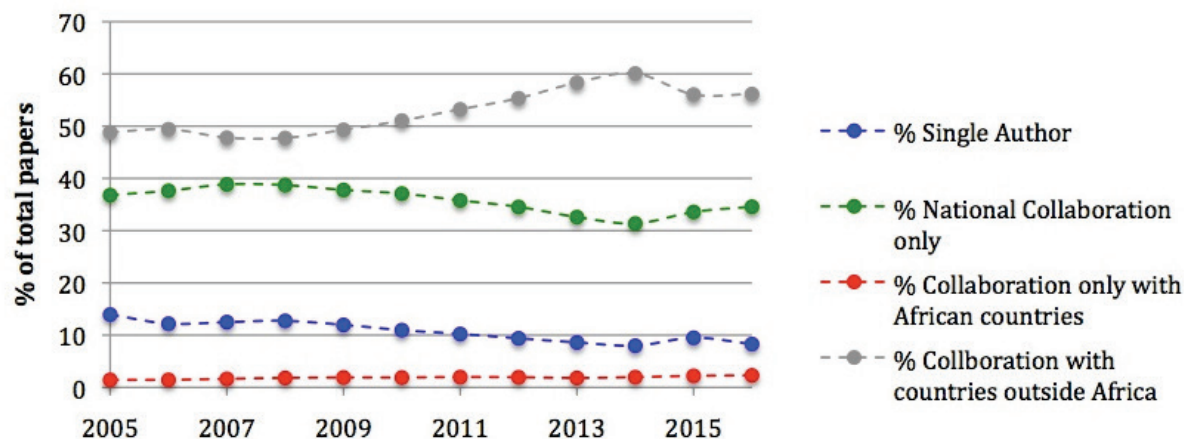
with institutions in the same country (national collaboration) which constitutes about 40% of all papers and papers where there is some collaboration between Africa and the rest of the world (international collaboration which is about 50% of all papers). The trend is clearly in favour of the latter.

⁹ One of the standard indicators used in bibliometric studies to measure whether a country (or region or institution) is particularly strong in a particular field, is the specialisation or activity index. We are not convinced that the term "activity" captures the notion of strength adequately. The term "specialisation" is equally problematic as it is more often used in discussions about specialisation within disciplines. Because this index measures the "relative" strength of a particular field or discipline compared to others, we refer to as the "Relative field strength index". A RFS value of 1 (indicated by a bold line in all graphs below) in a field or discipline implies that this entity (country or region) has a world

share for that field similar to its share in all fields combined. This is a "neutral" situation meaning there is no relative strength in that particular field. When the RFS index is greater than 1, the country is said to be strong in that field, at the expense of some other fields or disciplines for which the index is less than 1.

¹⁰ It is standard practice in bibliometric studies to use the co-authorship relationships of journal articles as a measure of research collaboration. We analysed different categories of research collaboration (as measured by co-authorship patterns) in articles where there is at least one author from an African country.

Figure 6: Africa publication collaboration profiles (2005 – 2015) (Source: Web of Science articles and re-



The increasing number of co-authorships (worldwide) should not be left without questioning. First we note large variations from one country to another. Not only do smaller countries tend to have higher collaboration proposals, but also collaborations are related to policy choices. Thus, for instance, Turkey, China, Brazil have much lower levels of foreign co-authorship (Jacques Gaillard, 2010), and in the three cases it is a choice to promote national publications that are reflected in the output measured by bibliometrics. Waast and Gaillard (2017) note that shares of internationally co-authored papers have increased in very high proportions in the last thirty years in all African countries. In some cases, as mentioned by N. Boshoff (2009), the proportion of foreign co-authored papers is very high (more than 80% in scientifically “small” countries of Central Africa) and a survey of African co-authors showed they were rather in charge of empirical fieldwork and data collection (Boshoff, 2009).

Another important element needs to be emphasized: the emergence of large international endeavours translating into a high volume of publications with an extensive list of co-authors from various countries, most of whom don’t even know each other or have not ever collaborated together. A large part of the increase of the production (yet to be calculated) relates to these “big science” projects such as international health projects in

Global Health, or very large particle physics projects such as ATLAS (Yami, Nordberg, Nicquevert, & Boisot, 2011). M. Kahn (2018) shows that in the case of South Africa, the surge of international co-authorship is the results mostly of these collaborative projects rather than active cooperation and partnerships.

These megaprojects blur the distinction between genuine collaborations among researchers and research units that indeed have worked together and the participation in large collaborative networks, funded globally, where units contribute to the knowledge base without necessarily being interconnected. Finally, from the point of view of researchers, in some cases international cooperation can be seen as “time-consuming, costly and often one-side”, as was the case in a survey of social sciences researchers in South Africa (CREST, 2014, p. 53). Although this might appear as strange and counterintuitive, it relates to the framework in which collaborations take place. Collaborations are welcome when they are the product of initiatives “from the ground”, or following tracks of well-established former contacts, with no important additional effort to be made. When levels of training and types of interrogations are very different, entailing some important effort in mutual understanding, collaborations will usually be rejected.

INVESTMENTS BY AFRICAN GOVERNMENTS IN (PUBLIC) R&D

Many African governments have committed themselves to increasing their gross domestic expenditure on R&D (GERD). GERD is generally regarded as a measure of how dedicated a specific country is to supporting research. But the reality is that most sub-Saharan Africa countries spend less than 0.5% of their gross domestic product (GDP) on R&D. Nigeria, for example, lags far behind in that only 0.20% of its GDP is assigned

towards the development of R&D (African Innovation Outlook 2010, p. 37). Unfortunately, not all sub-Saharan Africa countries' GERD is captured in the statistics below (Table 1). We lack therefore a comprehensive view of GERD in the region. In South Africa, the R&D Survey notes that "this ratio (GERD/GDP) has stagnated between 1.4 and 1.5 over the previous seven years" (HSRC, 2014, p. xiii).

Table 1. Gross domestic expenditure on R&D (GERD)

Country	African Innovation Outlook				UNESCO [†] Institute for Statistics
	Year	GERD Million PPPS	GERD per capita PPPS	GERD as % of GDP	GERD as % of GDP
Botswana	2005	n/a	n/a	0.38	0.52 (2005)
Burkina Faso	2009	n/a	n/a	0.18	0.20 (2009)
Cameroon	n/a	n/a	n/a	n/a	n/a
Côte d'Ivoire	n/a	n/a	n/a	n/a	n/a
Ethiopia	2005	n/a	n/a	0.2	0.24 (2010)
Ghana	2008	78.7	58.3	0.47	0.23 (2007)
Kenya	2007	277.8	7.4	0.38	0.42 (2007)
Malawi	2007	180.1	12.9	1.70	n/a
Mozambique*‡	2007	42.9	2.0	0.25	0.47 (2010)
Namibia	2005	n/a	n/a	0.3	n/a
Nigeria*†	2007	583.2	3.9	0.20	0.22 (2007)
Senegal	2008	99.0	8.0	0.48	0.37 (2008)
South Africa^Ω	2010/11	4976.6	102.4	0.76	0.87 (2009/10)
Tanzania*	2007	234.6	5.8	0.48	n/a
Uganda†	2007	359.8	11.6	1.10	0.41 (2009)
Zambia	2008	55.3	4.6	0.37	0.34 (2008)
Zimbabwe	2005	n/a	n/a	0.2	n/a

Source: African Innovation Outlook (2010: 34)

* Data do not include the business enterprise sector

† Data do not include private non-profit institutions/organisations

‡ Data do not include the higher education sector

^Ω HSRC CESTII Report (August 2013)

[†] We have added an additional column to include the latest available UIS statistics on R&D investment for selected countries

RELIANCE ON FOREIGN FUNDING

The second *Africa Innovation Outlook* (2014) published data on Africa's GERD by funding sources for six countries that completed the R&D survey for the report. Government funding of R&D activities is significant, albeit at very low levels in real money terms. Notably Ghana's government expenditure in R&D is the highest accounting for 68% of its research expenditure. Ghana also records the lowest expenditure from its business sector at 0.1% in 2010. In the majority of the six countries, contributions from the business/private sector are low. The outlier is South Africa,

where the private sector contributes over 40% of the total R&D expenditure. South Africa was also the least reliant on foreign funding with only 12% of funding being from outside sources. The Africa Outlook indicates that some countries such as Mozambique, Burkina Faso and Uganda received more than 50% of their R&D funding from foreign sources (Figure 7).

To illustrate this over-reliance on foreign funding, the figure below reflects the sources of funding for Makerere University, Uganda's flagship university (Hydén, 2017, p.97) (figure 8).

Figure 7: Proportion of international funding for R&D by country (2010 or latest year)

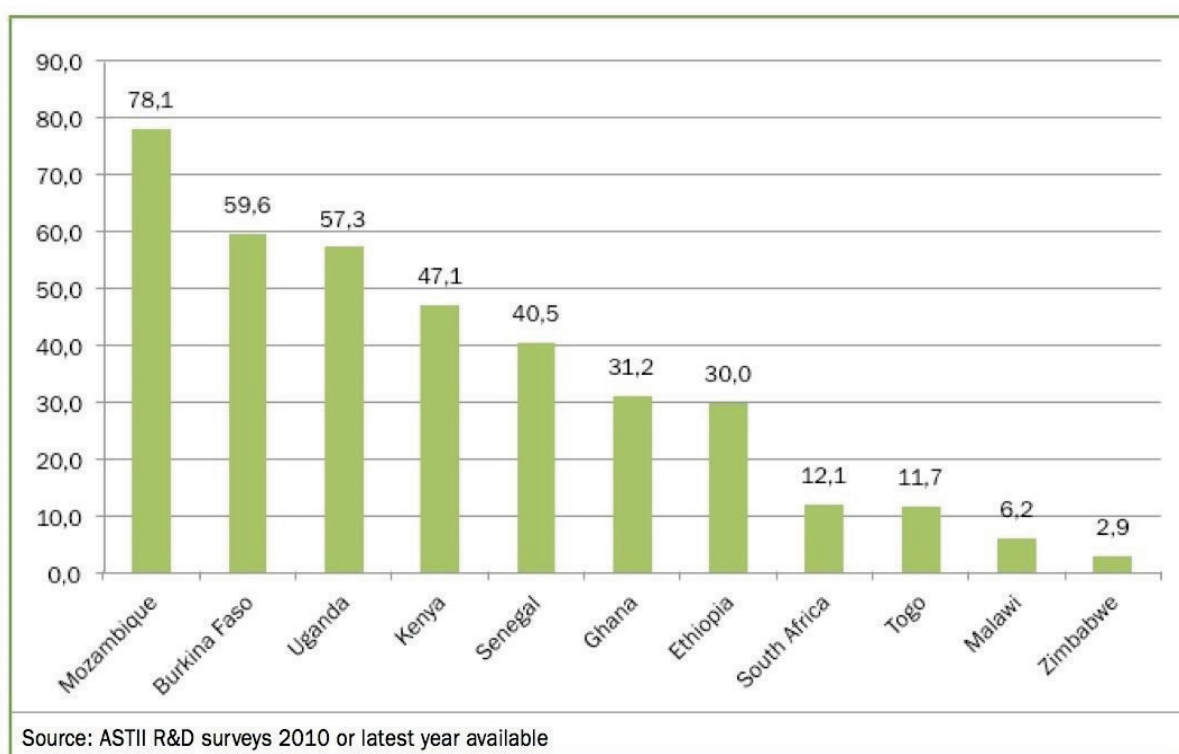
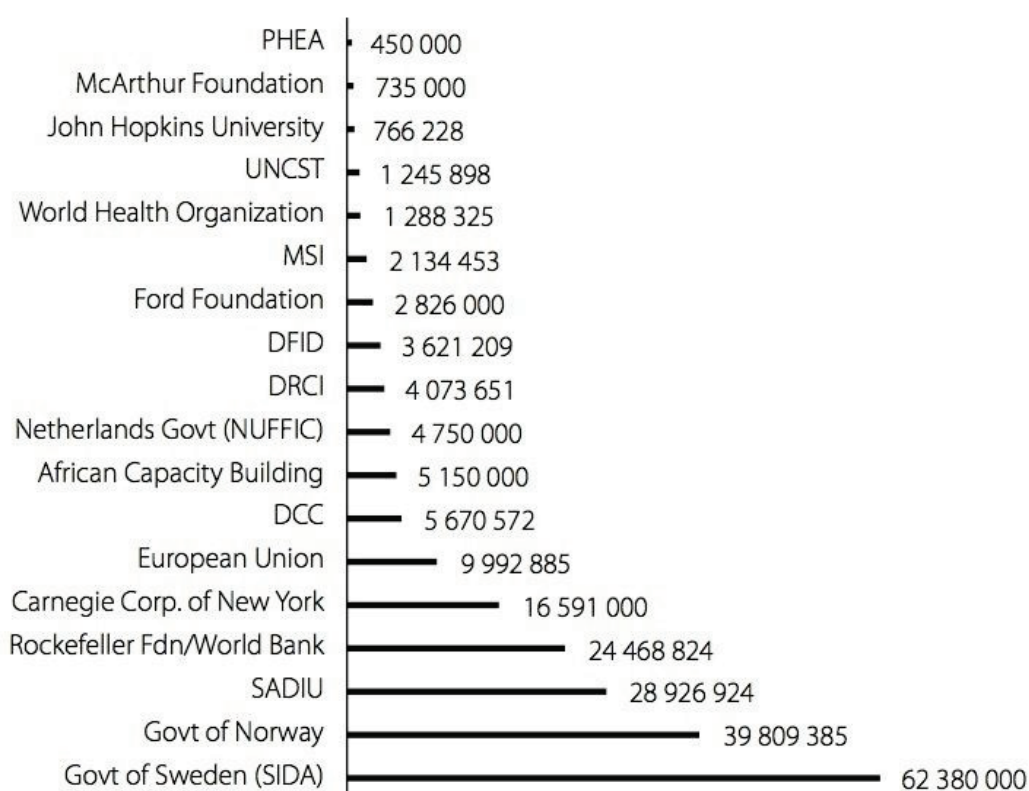


Figure 8: Source of R&D funding at Makerere University (2000 – 2012)



Note: PHEA = Partnerships for Higher Education in Africa; UNCST = Uganda National Council for Science and Technology; MSI = Millennium Science Initiative of the UNCST; DFID = Department for International Development, UK; IDRC = International Development Research Centre; CDC = Centers for Disease Control and Prevention; USAID = US Agency for International Development

Data source: Directorate of Quality Assurance, Makerere University

Of all of Makerere's funders over the 12-year period between 2000 and 2012 reflected above, the Uganda National Council for Science and Technology was the only local funder.¹¹ Makerere

University has sustained much of its research activities through the assistance of external funders among which two European countries (Norway and Sweden), the USA, two foundations and the EU.

DIFFERENT CONFIGURATIONS OF NATIONAL POLICY AND FUNDING

Science granting councils (SGCs) and agencies with equivalent missions such as national commissions for science and technology, national science councils and national academies of science

are essential actors in a country's systems of innovation. In well-defined and clearly articulated systems of innovation they perform a number of crucial functions that contribute to the effective and efficient functioning of such systems. Ideally,

¹¹ 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 (2016)

such councils act as fair and disinterested agents of government while, at the same time, representing the interests of the scientific community nationally, regionally and internationally. Thus, they are crucial ‘intermediaries’ in the flow of international funding and technical support to R&D-performing institutions in a country. The creation of Science Granting Councils and Competitive Research Funds is of a rather recent origin in sub-Saharan Africa. Over the past decade, however, we have seen an increase in either the establishment of dedicated science granting councils or agencies or the promulgation of policies stipulating that such agencies must be established in the foreseeable future. An empirical study by CREST examined the strategic priorities, objectives and practices of SGCs in 17 sub-Saharan African countries¹² (Mouton, Gaillard, & van Lill, 2014, 2015).

One of the main findings of this study on Science councils in Africa relates to the wide range and diversity of science funding configurations in the selected countries. Using the widely-accepted principal-agent framework, a number of questions presented themselves concerning the power relations and the distribution of tasks between the funding organisation and the principal organisation that it reports to. **Box 1** shows three examples of how these questions are addressed quite differently in each country. In the 17 countries investigated, four models capture the most commonly found organisational arrangements for public research funding.

The paradigmatic Principal-Agent model

It is the simplest manifestation of the principal-agent principle at work, where the government delegates its responsibility, as far as science or research funding is concerned, to a (relatively) autonomous body – usually referred to as a National Research/Science Foundation or Council. Although such a Foundation or Council receives its funds directly from the government and has to account for it on a regular basis (usually annually), it derives its autonomy through a statutory act of establishment and the appointment of a separate

Board or Council. This Council then establishes the required structures, policies and procedures to ensure fair, transparent and efficient disbursement of funds to public universities and research organisations.

Foundations would typically establish different “funding instruments” (scholarships, bursaries, travel grants, grants for emerging and established scholars, capacity-building grants and so on) to give effect to their mission. The best example of the paradigm case is the **South African National Research Foundation**. It was established in 1998 as a statutory body with its own council. It receives its funding from Treasury via the Department of Science and Technology and disburses this money through a wide range of funding instruments to South African universities on a competitive basis. Mozambique also has a similar configuration in that the NRF is directly responsible to the Ministry of Science and Technology. Other countries with similar arrangements are **Senegal**, **Côte d’Ivoire** and **Namibia**.

The sector-differentiated model

In many countries we found sector-specific funding agencies. In most cases funding agencies for **agriculture** and **health** (the two most common domains) have developed separately over time, usually reflecting the priority afforded to research in these two areas in most African countries. In addition, sector-specific agencies have their roots in inter-departmental rivalries and vested interests, which led governments to establish different research funding councils or foundations for different sectors in the science system (a usual case concerns telecommunications, as in Morocco and Egypt). We refer to this as the **sector-differentiated model**. A good example is the South African case where three bodies have a statutory responsibility for research funding: the **National Research Foundation** (which reports to the Department of Science and Technology), the **Medical Research Council** (which reports to the Department of Health) and the **Water Research Commission** (which reports to the Department of Water Affairs and Forestry). With

¹² This study was funded by the International Development Research Centre (IDRC) in 2012.

this configuration, it is not surprising to find that the funding agencies report to the different “principals” within Government. This fact, in itself, often causes challenges around co-ordination in science funding in the science system. **Burkina**

Faso has three funding agencies which report directly to their respective ministries: FONRID reports to the Ministry of Scientific Research and Innovation; FONER is responsible to the Ministry of Secondary and Higher Education; while FARES reports to the Ministry of Health.

In **Ghana**, the Council for Scientific and Industrial Research (CSIR) coordinates and administers the operations of the Science and Technology Research Endowment Fund (STREFund). The STREFund is an independent funding mechanism. One mechanism by which the Ministry of Environment, Science and Technology (principal) ensures that the CSIR (agent) is serving the interests of government in its administration of the fund is through co-representation. The STREFund is governed by a board of trustees of nine persons 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. At the same time, it could be argued that the representative board is also a mechanism by which the fund itself (as a second layer agent) satisfies the interests of the CSIR as its immediate principal.

Tanzania: The Tanzania Commission for Science and Technology (COSTECH) (the agent) is a government institution under the Ministry of Communication, Science and Technology (the principal). The National Fund for the Advancement of Science and Technology is located within the structure of COSTECH. The fund is an inter-ministerial fund channelled by the Treasury through the Ministry of Communication, Science and Technology. The fund is administered by an inter-ministerial and multi-sectoral committee, which comprises representatives of the relevant ministries (President’s Office, Treasury, Planning Commission, Communication, Science), the Bank of Tanzania, the National University, the Chamber of Commerce, Agriculture and Industry, and the Director General of COSTECH. Thus, through representation on the committee, the government, as principal, can ensure that COSTECH, as primary agent, is executing the fund in a manner that meets the national interest.

In **Zambia**, the National Science and Technology Council (NSTC) (agent) 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 principal). The mechanism by which the Ministry ensures that the NSTC serves the national interest in the administration of the fund is through dual fund management. The Strategic Research Fund is managed by two committees: the Technical Committee of the NSTC and the Fund Management Committee of the Ministry.

The embedded principal-agent model

A different configuration of the paradigmatic case is the embedded principal-agent model. Here the “agent” is not institutionally separate from the government (Ministry or Department of Science and Technology/ Higher Education). This was labelled as the “embedded agent” as the “agent” is organisationally part and parcel of a government department. In cases such as these, it is typical that

the “agent” is (1) either a sub-department or directorate within a Ministry or Department of S&T; or (2) a Fund/ Funding Programme that is administered by a department. Here the agent is simply an extension of government with no obvious autonomy or independence from the department in which it is located. One could argue that the agent, under this model, is not a proper “agent” (as suggested by the principal-agent framework) as it acts more as a commissioning agency than a disbursing agency. In fact, one of the best examples of the

“embedded-agent” model is that of COSTECH in **Tanzania** – the Commission for Science and Technology. In two other countries (**Namibia**

and **Rwanda**) these funding agencies are also referred to as “commissions”.

MULTIPLE PRINCIPAL-AGENTS MODEL (NATIONAL AND INTERNATIONAL FUNDERS)

This configuration can be labelled the “multiple principal-agents” model since additionally to the funding that is channelled from government (via some council or fund) to the universities, there are also various other “principals” at work in the national science system. These are typically international funders, foundations and development agencies, not necessarily specialised in research, but rather development agencies,¹³ who all channel funds predominantly to universities and research institutes, but also to NGOs¹⁴ in

African countries. In practice, we find many variations of this configuration, where many “principals” (national and foreign) co-exist (like “parallel universes”) in the same system. The review also found very little or no co-ordination or interaction between these separate funding channels. Such a situation obviously raises many questions: about priority setting, parallel lines of reporting and accounting, duplication, and so on. It is also to be found in international organisations, as will be mentioned below.

THE COMPLEX GOVERNANCE OF INTERNATIONAL FUNDING

In a recent report on North-South research partnerships, J. Dodson (2017) selected eleven programmes funded mainly by UK institutions as well as US, Sweden, Switzerland, Japan, and the Netherlands. This report can be read as an extensive analysis of the hybrid models of multiple principals-multiple agents. Dodson proposes to classify these partnerships by management structures, not based on the type of connection of the funding agent in its relation to the principal institutional actor, but rather on the distribution and partnering of roles in funding and management and the location of the management of the programme: Africa or in the foreign country.

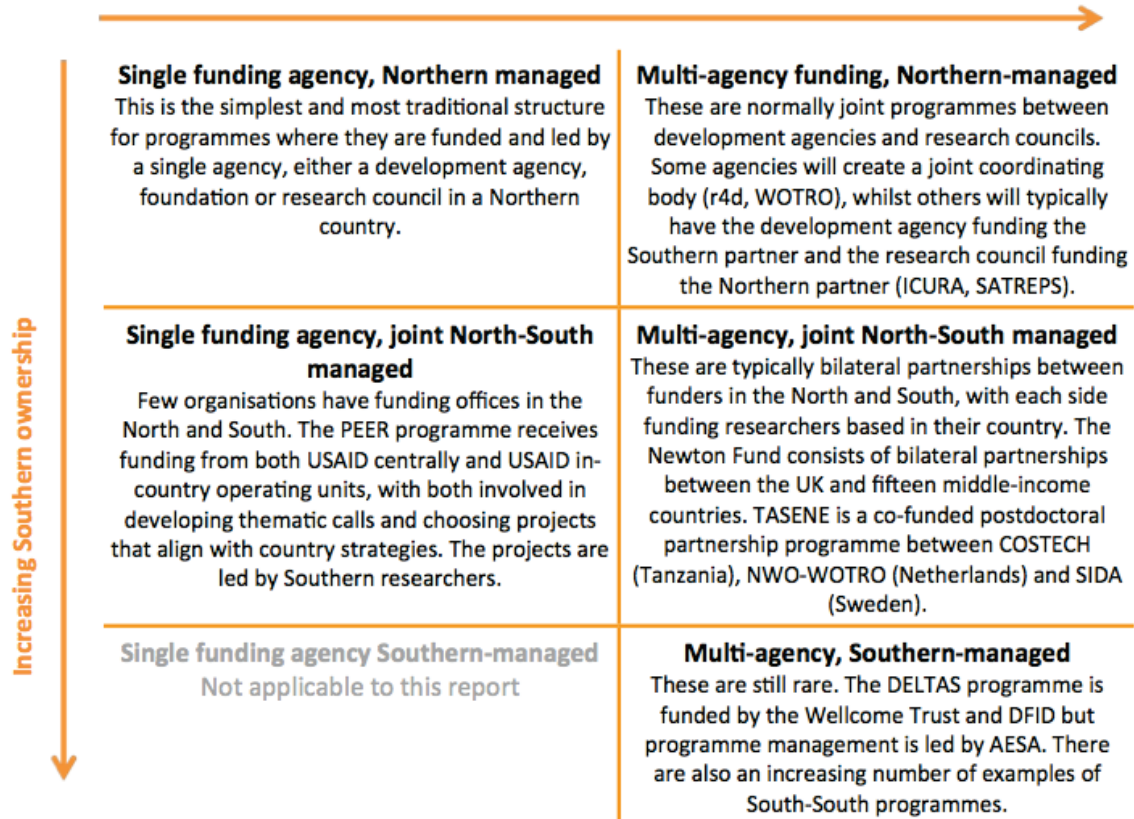
Thus, Dodson examines five main models of involvement of funders (her analysis excluded entirely national funding, which was the main focus of the SGCs study mentioned above). Concretely the role of funders—the main object of her analysis—depends less upon this complexity than other structural aspects (experience in research type of activities allowed, the objectives such as capacity building, learning and monitoring activities, the development of a critical mass...), the management of the selection and evaluation process, the financial rulings... Moreover, the underlying question of all the analysis is how to combine national authorities with “Northern” agencies and international funding agencies.

¹³ AFD (France), EU, SIDA (Sweden), CIDA, Wellcome, GTZ (GIZ), Danida (Denmark), NORAD (Norway), DFID (UK), Australia AID, USAID, DAAD (Germany), Carnegie Corporation of New York, Ford Foundation, Rockefeller

Foundation, Bill & Melinda Gates, PEPFAR, World Bank, and many others.

¹⁴ A most striking example is in Tanzania the Health and Care for Mother and Child which is entirely outsourced to a UK-based NGO (Hunsmann, 2016).

Figure 9: Dodson's (2017) five models of involvement of research funders



The variety of funding sources is not new. In a study carried out at the beginning of the last decade (Jacques Gaillard & Furó Tullberg, 2001a), 214 sources of foreign funding supporting research activities in sub-Saharan Africa were identified through a survey of African scientists. The main funding sources by far measured in number of project occurrences were USAID, the European Union, the French Cooperation, and WHO followed by IDRC, FAO, AUPELF/UREF, IAEA, the World Bank and UNESCO, in other words mainly international organisations, or institutions specialised in “research for development” of the so-called donor countries. Twenty years later, the analysis of actual funders today draws a very different and complex¹⁵ landscape.

¹⁵ As one such analysis of funding mentions: “Donor funding for higher education and research is complex and difficult to fully map and understand. Donors use different classifications and categories, which makes it tricky to identify funding flows and where these go” (Hydén, 2017, p.2).

The growing importance of private funding

First, private foundations are dominating the scene: they are richer than public funders (even those from their own countries) (OECD, 2018) and they have defined their domains of preference mainly in the areas of health (Nwaka et al., 2012), tropical diseases and epidemics (Head et al., 2017), in the wave of research for global health¹⁶. Large private philanthropic funding sources have provided funds through international bodies such as the WHO, that has earmarked nearly 80% of its budget, whereby donors designate how their “voluntary” contributions are to be spent¹⁷. As the OECD (2018) notes “while modest in volume compared with ODA [Official Development Aid], foundations are significant players in the health

¹⁶ Nwaka *et al.* (2012) derived a list of funders from 119 applications for the selection as Centre of Excellence in health innovation.

¹⁷ E.g. WHO’s 2018-2019 proposed budget of US\$ 4.421 billion is financed with US\$ 3.465 billion (78%) from voluntary contribution, mainly philanthropic organisations and the rest form core contributions of member states.

and reproductive health sectors, where they were the third largest source of financing for developing countries behind the United States and The Global Fund to Fight AIDS, Tuberculosis and Malaria. [...] An OECD survey found that private foundations provided USD 23.9 billion from 2013 to 2015, averaging USD 7.96 billion per year (OECD, 2018). Eighty-one per cent of these funds came from just 20 foundations. The Bill & Melinda Gates Foundation is the most significant of the 143 foundations surveyed, providing 49% of total philanthropic finance. Its aid has risen over the past five years by nearly 50% in real terms, reaching over USD 3 billion in 2016. Middle-income countries received 67% of country allocable philanthropic funding and just one-third benefited the Less Developed Countries. Almost all funding (97%) was implemented through intermediary institutions. Africa was the largest beneficiary region, receiving about a third of this aid.” The OECD suggests that “official” donors (DAC members) could engage more systematically with private foundations. Many initiatives, in particular in health, are also a blend of private and public funding, as for e.g. the African Biosafety Network of Expertise (BMG funding). Private funding is changing the very notion of “agenda-setting” (Vessuri, 2017). The old paradigm of scientists defining the areas of funding and research, based on their research experience is mediated by the dynamics of large funding (philanthropic) bodies that are supposed to convey research to comply major societal needs. Also, large private funders tend to now associate either to multi-lateral bodies such as WHO (Chorev, 2012) and multi-agency funding schemes.

Co-constructed, co-owned and co-funded

Secondly, “donors” (institutions in country members of the Development Assistance Committee) were defining, once, the agenda as part of their participation to aid policy. Donors select the countries they worked with, because of political affinities and the colonial past (Jacques Gaillard, 1999), as well as because of diplomatic relations with other donors —usually all members of the

small club of the Development Aid Committee. Today, in the era of co-construction, few funding agencies would choose to work alone, without engaging in some form of common engagement with local authorities. Moreover, “cost-sharing” is actively promoted by the World Bank, and encouraged by the OECD, that is public-private partnerships are supposed to be the best way forward. Donors and foreign agencies do not any more provide technical assistance or even research funds. They participate in the design and delivery of policy instruments, under the assumption that “co-constructed”, “co-owned”, “co-funded” policy measures between foreign partners and national performers and policy bodies will have a better chance to create a space for scientific research. This has been particularly the case for the European Union through its projects devoted to promote international collaborations through funding available to science policy institutions and partnering projects (called INCO projects for International Collaboration). Thus agencies and Science Councils in their relations to foreign partners, although not very rich, play a key role in linking this external, global environment to the national needs.

Funding through large initiatives

A third change is that large ‘initiatives’ are now the name of the game. Programmes aimed at multi-annual support, and seeking to produce an impact through the sheer weight of concentrated resources have led to the idea of ‘centres of excellence’ and large networking initiatives combining public and private sources of funding as well as various types of institutions. A number of initiatives have been instigated to create research centers (such as AIMS). The general idea here is to promote “clusters of knowledge” that would produce a concentration of resources in a single location, allowing for the exchange of ideas, profit from common investments and define shared agendas.

The best well known such initiative, the African Centres of Excellence¹⁸, was launched in April 2014 by the World Bank. Topics range from

¹⁸ <http://www.ace.edu.ng/ace/about/>

health to environment, as well as some fields like materials, oil chemistry, applied mathematics and computer sciences. These centers have trained around 3000 faculty personnel inside the centers, and more than 2500 faculty nationals from these countries or from African countries (World Bank data¹⁹). A second series of 24 centres was launched in 2014 for Western and Central Africa, with 19 centres of excellence selected across seven countries.

Additionally, in 2012, the West African Economic and Monetary Union (WAEMU / UEMOA) designated 14 centres of excellence. Their focus is on quite different topics than the World Bank funded centres (education studies, demographics, justice, business, management and economics, urban studies as well as water and environment. Most of these centers receive national and foreign funding, the latter being usually the main source. The process of selecting and approving these excellence centres has been documented in the case of 32 Centres of Excellence in health (Nwaka et al., 2012).

All these excellence centres may have differing mandates, but they all participate in training researchers (Masters and PhDs), establishing partnerships with national and foreign universities, and businesses as well as creating synergies at the sub-regional level (equipment, etc.), or promoting management and governance models that are supposed to be “role models” for the partnering universities.

An important initiative of the EU 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 patients. It has also helped to train more than 300 African scientists. The EDTCP is in Phase two (since 2014) and is scheduled to receive EUR 2 billions from the European Commission over the next ten years²⁰. Calls for projects are co-funded

by participating entities with the European Commission.

EDTCP is built on a provision of the Treaty of the Union in article 185, that allows for research to have multi-year programming with multiple partners. Article 185 has also been used in partnerships with countries in the Baltic Sea (including Russia), and more recently with PRIMA initiative that concerns Mediterranean neighbourhood countries.²¹ In the Med region, PRIMA has been negotiated while funding was channelled through two ERANET projects: ARIMNET in Agriculture and ERANET MED. The policy conditions and supporting activities were designed to be included in MED-SPRING which was an INCO project under FP7.²²

Bilateral programmes between North and South continue

In addition to these large initiatives, the usual scholarship programmes (Marie Curie funding, Newton Fund, bi-lateral scholarships) and bilateral cooperation schemes continue to exist.

Other initiatives are more traditional, based on funding scholarships or grants to individuals. The Newton Fund, created in 2014, has been particularly designated as a successful venture (Grimes & McNulty, 2016): it consists of bilateral partnerships between the UK and fifteen middle-income countries in order to provide appropriate frameworks for support and funding opportunities.

Within universities, various research-related initiatives can already be found. In Tanzania, cooperation between the Muhimbili University College of Health Sciences in Dar es Salaam, the University of Heidelberg (Germany) and GTZ in the early 2000s led to the introduction of a first Master of Public Health Programme. In South Africa, remarkable achievements regarding the transformation of the higher education landscape were accomplished through the so-called ‘South Africa Norway Tertiary Education Programme’ (SANTED). Starting in 2000, it aimed at improving the access, retention and success of previously

¹⁹ <http://projects.worldbank.org/P126974/strengthening-tertiary-education-africa-through-africa-centers-excellence?lang=en&tab=results> accessed 27-07-2018

²⁰ <http://ec.europa.eu/research/iscp/index.cfm?pg=africa>

²¹ PRIMA will concern also North African countries (Egypt, Tunisia, Algeria, Morocco) and Middle East countries.

²² MESDPRING was built among the same partners as MIRA (Morini, Rodriguez, Arvanitis, & Chaabouni, 2013).

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 16 universities in South Africa and the SADC region (Gibbon, 2014).

Less publicized in Anglophone literature, the French science diplomacy has used this scheme of bilateral funding since at least 30 years, expanding

to today's Programmes Hubert Curien, which are co-managed bilaterally by a French and national committee of the partnering country²³. PHC are particularly active in North Africa and the Mediterranean region as well as in Africa and Latin America, and now Asia (67 PHC or similar programmes are currently under way with foreign partners. They account for over 2,000 projects every year). Long-time known by scientists in French-speaking countries, these programmes promote mobility rather than local capacity building.

VARIOUS STRUCTURAL EFFECTS OF FUNDING

These changes discussed above have had various consequences, but three appear to be more important.

1) The necessary involvement of national institutions. A first result has been the necessary relation with national institutions; institutions that, even if new or inefficient, are legitimate owners of policy areas in their country. As such they are the 'natural' partners of donors. In some cases, donors have to provide support in the creation of the policy-making institution. This is the case of the Millennium Science Initiative in Uganda (World Bank & IEG (Susan Ann Caceres), 2016), a country where Donors finance approximately 30 percent of the government's annual budget. The country with its newly reformed Ministry of Education, science, technology and sports, received US\$ 16.69 million fund for research grants, enhancing the education programmes, and create linkages between academia and industry. Not all cases are as strongly supported by global funders as in the case of Uganda, although this country, along with Tanzania, stand out as the preferred investment countries for development funds related to research. These investments are mainly in the health sector (Head et al., 2017) and for development aid activities (Hunsmann, 2016; Koch & Weingart, 2016).

2) Complex governance. A second consequence is that complex governance issues arise because of

multilateral arrangements that are increasingly becoming the norm for the future. For management needs, a foreign funding agency can choose to manage "on its side" specific funding schemes, or find solutions permitting to keep some control on funds even though participation of the national (local) funding entities have to be taken into account. But in no circumstance is it possible for a foreign agency, even a powerful one as the USAID, to pretend defining the agenda alone anymore. The hybrid management practices become the norm. A striking example is the Japanese SATREPS: JIICA (the development agency) funds the local partners, while the Japan National Research agency (JIST) and the Medical research council fund the Japanese partners.

When working in large programmes with multiple foreign sources of funding and some locally designed institution, where a national authority participates but as one among other agents, and *not* as a principal directing the system and its subsequent funding, one could come-up with a hybrid embedded principal-agent model. All these hybrid cases of embedded principal-agent models pose governance issues and also raise questions as to who and how the funding should be directed.

The multi-participations of different foreign funding agencies and Donors, affect directly the agenda-setting activities. They imply, more often than not, measure and analysis instruments. Cabane and Tantchou (2016), after editing a

²³ <https://www.diplomatie.gouv.fr/en/french-foreign-policy/scientific-diplomacy/scientific-partnerships/>

collection of field studies of public-private, national/foreign interventions in Africa mention that “international donors no longer impose conditions from the outside, but prefer to act from within African states through techniques, measurements, standards, evaluation tools and specific terminology.” One can also see that foreign funders cannot avoid being embedded into common cooperation schemes with granting councils, those being necessary representatives of local political forces.

J. Dodson (2017, p. 28), writing from a pragmatic point of view, that of North funders, mentions a series of efforts within partnerships addressing the “unequal power dynamics”: awarding letters sent to all grantees underlining that funding resulted from joint successful bid with joint responsibilities, site visits from the funders to localities where funding is used; intensive communication from management people with project coordinators; creation of a specific financial management capacity in “r4d programme” (Swiss cooperation) and PEER (USAID) or direct administration support to grantees (IDRC); encouraging Southern leadership (example of Africa Capacity Building Initiative).

3) Unknown effects on research careers. Finally, it should be mentioned that this new funding landscape has produced effects on the research landscape and, as yet, are not properly understood. In a small country like Niger, among the poorest countries in Africa, which counts approximately 400 researchers, an analysis of acknowledgments in publications indexed in Web of Science (1995-2015) shows the strong presence of foreign funding from French research institutions (20%), EU (13%), USA (13%), private foundations and NGOs (15.5%) among which BMG dominates with a variety of funding schemes (9.3%), international organisations like WHO, ICRISAT and other CGIAR centres (10%). National funding accounts for very few acknowledgments (less than 2% of the papers) (Marou

Sama, 2016).

It is always mentioned by advocates of the various funding programmes that the effect can only be beneficial for developing countries but can be sometimes considered adverse for the “high-income countries researchers” (Chu, Jayaraman, Kyamanywa, & Ntakiyiruta, 2014). These medical researchers state the challenge rather simply: “How can the advancement of African research capacity and academic careers be prioritized while satisfying the ‘publish or perish’ mandate of high-income countries’ universities?” (p. 2). Most of the literature on the subject is rather normative and insists on the qualities that are supposed to be brought by cooperative partnerships.

The impact of foreign funding on research careers has rarely been an object for study either in rich countries or in the developing world. But since the pioneering study of J.Gaillard (1991, first published in French in 1987), some surveys have shown that the impact of funding is extremely strong on careers. So much so, that the prevalent view in Africa was that one should follow the funding, thus entering in a sort of permanent pursuit for contracts as expert rather than researcher. Thus, entire careers in Academia could be built (Marou Sama, 2016) by securing simultaneously a close connection to some foreign individual researcher and obtaining funds from calls and working as expert for international organisations (see the interview of Abdou Salam Fall in Dakar in Vidal, 2014). Recently, this bias has been underlined in a survey on French-written literature on research on education in Africa, where the authors (Gérard & Pilon, 2017) find many consultancy reports and relatively few research material. These authors see this change as a danger entailed by this short-term career-building; it seems that funders have taken into account this new way of professionalisation, and partly translates in these large initiatives.

SOME STRUCTURAL ASPECT FOR CONSIDERATION

Nurturing research in Africa can be examined through many lenses. Here we will underline some structural constraints concerning investment and funding, employment, and the institutional framework of research in Africa.

Universities as the main locus for research

A reasonably well structured research system contains various types of performing institutions: universities, public research organisation (PRO), private research organisations, R&D units of enterprises, NGOs, funding organisations (official, philanthropic foundations, etc.), “intermediate” organisations... The growing complexity of the research and innovation landscape should not conceal the fundamental role played by universities.

Philip Altbach has insisted on the necessity to sustain research universities in the developing countries. He has argued that universities are neither a luxury nor an unnecessary investment “Research universities provide the skills needed by twenty-first century economies and societies and reflect the best academic values. Research universities are central institutions for the global economy” (Altbach, 2009, p. 26). Like other thinkers working on studies of higher education, he has been insisting on the fact that the power engine of the knowledge economy is universities.²⁴

It should be reminded that the defense of *research* universities in Africa in the eighties and nineties was contradicting directly the ideology that permeated most aid policies when the World Bank, after its 1986 “infamous report” (as described by N.Cloete), concluded that development efforts in Africa should be refocused to concentrate on primary education. It took more than ten years and the profound debt of Africa to change the whole view on universities. Today, there is growing consensus on the necessity to promote research in

universities, even though universities in Africa confront structural difficulties.

Supporting research universities will not be a simple straightforward process. There are various reasons, among which the various roles of universities, as explained by Manuel Castells in his conferences in Africa (Muller, Cloete, & van Schalkwyk, 2016). Beyond the usual functions of training, research and dissemination (or third-mission), Universities serve as producers of values and social legitimate knowledge, selection of the dominant elites, training of the educated labour force in particular for the state but also the economy in its entirety, producers of scientific knowledge but also actors in the uses of knowledge. In other words, universities are a development engine, and necessarily have contradictory social roles (Cloete, 2015).

Universities are seeking to strengthen their research potential, in Africa as in other continents (Krishna, 2018). Some universities tend to adopt quality criteria and promote research, as well as an international policy (Cloete, 2015; Cloete et al., 2011) and develop effective international partnership agreements.²⁵ Universities also participate actively in policy-making activities, issuing policy and monitoring functions, either towards research, teaching, or management throughout the African continent (Bailey, 2015). These bodies, reviewed in seven countries, have no comprehensive view of the higher education system (except two: South Africa and Mauritius) and have difficulties in leveraging data on the higher education, and in imposing sanctions or apply incentives in the implementation of quality standards (Bailey 2015, p.195). Bailey also refers to political interference, difficulties that relate to diverging views on the role of higher education, “the absence of a clear pact (or agreement) amongst key stakeholders regarding the vision for Tertiary Education and Higher Education in the

²⁴ This is better exposed by Altbach but numerous studies from such authors as M. Castells, J. Ziman, or N. Stehr offer abundant social and historical evidence of this fact. The metaphor of the “triple helix” (Etzkowitz & Leydesdorff, 1997), wider than that of the “entrepreneurial university,” situates the contribution of the university

into a complex web of relations with research and the economy.

²⁵ A recent study in Tanzania and the Democratic Republic of Congo (Chiteng Kot, 2014) found that, “roughly, 4 in 10 university administrators, academic staff and post-graduate students at the two institutions had participated in international partnerships” (p.267).

country and, linked to this, very limited coordination at the system level. [...] To the extent that the councils/commissions were operating in the absence of a pact and limited coordination, they were vulnerable to fluctuating external influences and mixed messages (e.g. shifting priorities/agendas or demands from the environment, or duplication, confusion or gaps within the broader governance system)” (p. 196).

Moreover, and this is also new, the *quality criteria* become regional, with international and regional bodies such as CAMES (francophone Africa) certifying the quality of Master and Doctoral programmes. The role of CAMES in French-speaking Africa is somewhat stronger than just proposing a harmonization of quality assurance. By certifying the quality of research in universities, it legitimises the value of research (Cissé, 2018). The labelling of research units inside universities seems to have strong effects, as the Tunisian experience has shown (a fourfold increase of science production as measured by research articles after the labelling took place), if it is accompanied by a substantial increase of funding (Arvanitis, Hanafi, & Pancera, 2014).

We know of two series of studies following and up-dating the information on large research Universities in Africa. One such series of observations was the HERANA project that involved eight large universities, all in Anglophone Africa and Mozambique²⁶ (Cloete, 2015; Cloete et al., 2011). Another study was a flagship (national) universities study by D. Teferra²⁷ (2016).

In a synthesis on the teaching and research in African Universities, P. Zeleza (cited by Cloete, 2015) mentions a series of structural challenges: linking the university to industry and National Development Plans with stable funding and implementation, confronting the massive expansion of students population, providing incentives for the business sector in order to promote industry-university collaborations and promoting scientific literacy to popularise STI in society. And N. Cloete concludes that “a university cannot become

research-led (or intensive), or world class, if it is not part of a national and policy framework with differentiation, that is allowing to identify and promote research.”

Despite this apparent consensus on the role of universities, international research funding as well as high-level policy statements (such as the Africa Science and Technology Consolidated Action Plan) rarely “recognise explicitly or primarily position universities at the core of the overall science and technology capacity building strategy” (Obamba, 2013). Similarly, when designing its policy, the European Union predominantly focuses on partnership aimed at building ‘science and technology’ without mentioning universities. “Capacity building” was for long time designed to happen outside academia. It is time to re-integrate universities and target them as the main recipient of funding for research.

The difficulty to invest in research activities

African countries invest little in research and the recent up-surge of research activities that we have witnessed, as measured by GERD/GDP ratio, is still very fragile. Beyond the wishful thinking and necessary optimism of any policy-maker and researcher that would like to see a continuation of this trend, an appropriate and robust explanation is needed. But explanations that link available investment in research and effects on the economy and on society are now necessarily systemic (Georghiou, 2015), and imply a serious reconsideration of the role of policy (Mazzucato, 2013) and the way knowledge production organisations are working together. In effect, more than 50 years of research and innovation studies—a domain of the social sciences that has been predominantly European—have shown that no one single factor can be used in explaining this generic success. Moreover, the various meanings of the value of science (Science Europe, 2017), the complex relation of research with society, the role of universities make any assessment a complex exercise. Funding

²⁶ The project has conducted several rounds of theory-driven empirical studies that involved the flagship universities in eight sub-Saharan African countries: the University of Botswana, the University of Cape Town (South Africa), the University of Dar es Salaam (Tanzania), Eduardo Mondlane University (Mozambique), the

University of Ghana, the University of Mauritius, Makerere University (Uganda), and the University of Nairobi (Kenya).

²⁷ Addis Ababa, Botswana, Cairo, Chiekh Anta Diop, Dar es Salaam, Ibadan, Ghana, Makerere, Mauritius, Nairobi, and Zambia.

excellent research by itself does not produce development. This issue is of paramount importance for a foreign funding agency as well as for a national authority.

Funding agencies, research councils, and other funding agents play a decisive role in this. But they are far from being the only actors in this arbitration between excellence and relevance. On the front of funding agencies, in their study, Erika Kraemer-Mbula and Robert Tijssen (2017) note that research excellence perceived by researchers and research administrators as “(1) creating awareness of societal issues, (2) direct benefits to disadvantaged communities, and (3) new technological developments. This is an indication of the perceived need for a closer connection between research outputs and end users (communities)” (p. 399). The increasing weight of users on research is changing the meaning of research and innovation (Joly, 2017) and African research is no exception. This is also evidenced by the answers to the survey just mentioned where research excellence, when described by respondents in their own words “its ability to solve a problem, improve the lives of people (particularly those marginalised or disadvantaged), or change policy” (p. 400). But the concrete exercise of estimating the contribution of a research programme is a difficult one, as evidenced for example by the experience of the National Research Fund (FNI) of Mozambique (2015) that could not obtain responses from grantees of its own fund.²⁸

It also appears as increasingly necessary for any funding agent, and particularly for a foreign one, that an assessment framework should be designed, as part of the effort to support research. In this respect the International Foundation for Science (IFS) with its evaluation framework is a valuable and unique international experience.²⁹

Employment and circulation of scientists

Increasing the number of researchers is arguably the most important priority for policies supporting stronger research and innovation systems in Africa. In all African countries there is a shortage of highly-skilled personnel, as well as insufficient training of Masters and PhDs. This explains the important number of African students in Europe, USA and other countries. But circulation is not limited to going to Europe and the US. In 2009 a total of 60,856 foreign students were enrolled in South Africa’s universities, placing the country 11th worldwide for the openness of its higher education system. Some 43,587 of these students were from Africa, with SADC countries accounting for 41,635, a level of 6.9 per cent of enrolment that is way above the SADC target of 5 per cent. Moreover, foreign students from other African countries in South Africa in 2016 represented 38% of all South African PhD students. Enrolments from other African countries keep on growing at a faster rate than enrolments from within South Africa (Cloete, Sheppard, & Bailey, 2015).

Curiously enough, and judging from the situation of South Africa (Kaplan & Höppli, 2017), the labour market for highly-skilled personnel is not growing as fast as expected even though there is evidence of missing skills and of training capacities (and growing enrolment rates in all types of Higher Education institutions). And the prospect is not encouraging since economists tend to consider that the international competition is going to get tougher to attract high level talents; some countries have already adopted specific measures to do so.

In 2005/06, over half of the migrant populations originating from India, Nigeria, the Philippines and South Africa were highly educated. Since 2000, the share of high-educated persons increased in all main emigrant groups, but most notably for Indian migrants (+8 percentage points

²⁸ The evaluation of FNI was initially intended to be based on a survey of principal investigators of the 208 funded projects (2006-2013), but response rates were very low. It seems that international funders, when they do similar surveys, have better response rates, as exemplified by the surveys done by the International Foundation for Science to this African researchers either

funded by IFS or the EU (INCO DEV programme) at that time (Jacques Gaillard & Furó Tullberg, 2001b).

²⁹ The activity of IFS has been well documented, as well as its an evaluation framework, called MESIA, which combines bibliometrics, surveys among beneficiaries and institutional analysis. The evaluation methodology has been used in Vietnam, Africa and Mexico (<http://www.ifs.se/ifs-publications/>).

compared with 2000). In 2005/06, there were 550,000 recent high-educated Indian migrants in the OECD. China is the second most important country of origin with 320,000 recent highly skilled migrants, identical to the total for Sub-Saharan Africa. More recent data on the highly educated migrants from North Africa and Sub-Saharan Africa is 460,000 (Database on Immigrants in OCDE 2000 and 2005/2006, see Widmaier and Dumont, 2011).

Countries with a high population growth tend to show limited increases, or even decreases, in emigration rates. For example, eastern African countries such as Rwanda, Burundi or Eritrea experienced very rapid increases of their populations between 2000 and 2005/06, but limited changes in emigration rates. Countries for which emigration rates of the highly skilled increased the most are Congo (+25 percentage points), Zimbabwe (+20 percentage points) and Malawi (+19 percentage points).

In Africa, the emigration rate of the highly educated is on average around 10%, but for some countries it can be much higher. For example, about half of the highly educated from Congo (61%), Mauritius (50%) and Zimbabwe (49%) live in an OECD country. Usually, larger countries have around average emigration: some 10 per cent of South Africa's most highly skilled are living abroad, which represents an estimated 540,000 South Africans residents in OECD countries, and 54 per cent of these have tertiary qualifications. According to a demographic analysis published by the OECD, North Africa is the only region of the World where a decline in the emigration rate of the highly educated has been observed since 2000 (-1.2 percentage point). This is due to the rapid improvement in the share of persons holding tertiary degrees in that region (2011). Finally, it is useful to note that Europe hosts 8.9 million Africans, out of which 2.4% are tertiary educated and 10.3% are considered 'brain drain'³⁰, that is permanent residents in OECD

countries (73% in Europe and 15% in the USA).

To counteract the "brain drain" two options are discussed. The first one is mobilizing the diaspora, and the second is the return of emigration. A third option is the idea that the highly educated is a highly mobile population and circulation of the highly-skilled should be encouraged. In effect, today circulation is not restricted to the two options of mobilizing the diaspora and the return option, but the circulation occurs between different countries where highly qualified people may be needed and find attractive positions whatever the nationality. The new Argonauts, a metaphor proposed by Saxenian (2006), are those professionals that circulate as global citizens where their skills are needed. Given the caveat announced by economists on the unequal distribution of this global circulation of talents, one should be careful upon generalizations.³¹

The diaspora option, the idea of networks of diasporas to mobilize the diaspora, was enthusiastically proposed in Latin America and still exists through programmes of the UNDP like TOKTEN, and others.³² The more important experience in Africa has been the South African Network of Skills Abroad (SANSA) network in South Africa (ceased in 2006). It was designed and driven by academics, and was to be a different model than the cases of Ireland or India, where skilled professionals returned home to open new businesses and create new industries (Silicon Bog and Bangalore). Another experiment in the case of business, the South African Diaspora Network, in 2001 sought to build business-to-business links abroad. It ceased operation in 2003. M. Kahn (2015) also mentions "a number of NGOs that seek to bridge the expatriate-home gap has emerged" that use the web.³³

Diasporas are visibly difficult to mobilize and even seem too far away from home in order to make a real contribution. Two surveys on research collaborations between Latin America and Mediterranean countries with Europe showed

³⁰ Emigration rate is the share of the native population of country residing abroad at a certain moment, and "brain drain" is the emigration rate of persons holding tertiary degrees.

³¹ These options have been discussed in a collection of articles published in *Science, Technology and Society* 20/3 (2015) (J. Gaillard, Gaillard, & Krishna, 2015). Also a

critique of the quite naïve view of the Saxenian Argonauts is provided by JB Meyer (2009).

³² We have been reporting on this Tokten programme and these similar intents in the case of Arab countries in our book (Hanafi & Arvanitis, 2016).

³³ www.homecomingrevolution.com and 'SABLE' or SA Business Links to Experts www.sablenetwork.com.

that diaspora plays a minimal role in decisions about travel, collaborations or even studies abroad (A.-M. Gaillard, Canesse, Gaillard, & Arvanitis, 2013; Jacques Gaillard, Gaillard, & Arvanitis, 2013). Worse, there is often too much inequality between the expatriate professional and the African 'local' researcher that creates a tension far more difficult to manage than the relation between a North and a South researcher.³⁴

Finally, it should be mentioned that few sociological studies or surveys exist that try to survey exiled skilled persons. One such study on South African medical practitioners residents in Canada concluded that these persons do not seriously consider returning to their homeland (Crush 2012 cited by Kahn, 2015).

Brain drain is still a reality and is there to stay. From the point of view of the country of departure, the emigration represents very high losses, in particular when comparing to the inflow of highly skilled. South Africa is an attractive country to the highly skilled, but still the number of South Africans leaving the country reaches an average annual exodus of 8,500, half of whom would be highly skilled. This loss is ten times the inflow to South Africa. As Kaplan and Höppli (2017) indicate: "contrary to some views, there has been no mass immigration of returning skilled South Africans. The most recent data suggests that the rate of net outflow is on the increase again. The continuing and likely accelerating emigration of skilled South Africans – now not only white, but increasingly black, Indian, and coloured South Africans – together with the need to enhance the growth rate and employment, make consideration of this issue vital and urgent".

The second option is repatriation. The idea that the strengthening of the national scientific institutions would be enough to retain the human resources locally is only partially effective. A series of conditions need to be in place: the necessary development of an advanced infrastructure is needed, and is a necessity to attract highly qualified personnel, as testified by Singapore and India.

But coming back is usually "painful, demanding and challenging process" and sometimes it is really not an option (J. Gaillard et al., 2015, p. 274). In Morocco a network of expatriates has been encouraged (Azzoui & Menéndez, 2013) and some professionals did come back and integrated high-tech enterprises that were created in Morocco and heavily subsidised. All this is marginal (and expensive) mobility.

Nonetheless, circulation is directly linked to the training of the highly qualified working force, mainly during the doctoral studies of Africans in foreign countries. The PhD is usually done in a much longer period for African students than Europeans or US students, way more painful, relatively costly, and often less continuous over time (Kojoue, 2017). But maybe because of this difficulty, high-level skilled personnel that enters research and academia could be more mobile, and circulate rather than emigrate from their country. In the recent study on Young Scientists in Africa,³⁵ concerning mobility, it was found that 30% of more than 5,700 respondents had studied overseas. The highest rates were found for the Agricultural sciences (36%) and humanities (39% but for a smaller quantum), and other disciplinary areas all between 27 to 29%. Even more surprising were the results when we disaggregated by age interval. For many of the analyses the sample was divided into three age groups (39 years and younger, between 40 and 49 and 50 years and older). The study found that the early career academics (39 and younger) are the more mobile and definitely more mobile than the late career academics. This would suggest that the current cohort of early career academics have had more opportunities to study and work abroad (and returned to Africa) than those who are older than 50. Again, circulation is the main tendency, younger professionals in training finding easily opportunities to travel abroad, as compared to the immediate older generation. This pattern is evident across all science domains (with few exceptions).

³⁴ Some recent case-studies of African professionals have been published in a special issue of *Revue d'anthropologie des connaissances* (2018, Vol.10, n°4), edited by Hamidou Dia and Luc Ngwe.

³⁵ A project directed by J. Mouton (CREST) and C. Beaudry (Polytechnique Montréal).

FUNDING AS PART OF A POLITICAL ECONOMY OF RESEARCH

Our analysis has provided sufficient evidence about recent studies on the state of research institutions in Africa: historical studies, political and sociological analyses as well as analyses of the institutional framework. These studies clearly demonstrate the growing importance of universities, learning and training (especially in post-graduate studies) in Africa. They also show that there is a growing realisation of the importance of research in the academic environment. Nonetheless both scientific employment and investment in research remain very low.

But the winds are changing. In most African countries we see efforts towards the consolidation of research universities. We also see the emergence of national authorities concerned with science and technology and newly established national funds dedicated to funding research. At the same time, research, in all areas, 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 the “national priorities” of their African partners, or at least the needs of African populations. This is risky for foreign funders since these “national priorities” are not always expressed clearly by the African authorities. The possible neo-colonial modes of functioning of foreign partners through international collaborations, even where funders attempt to avoid this, remains a concern.

In the final analysis, knowledge production in many countries remains very fragmented or occurs with less than a critical mass. This is due to various factors: the low numbers of academic and research population, low if non-existent participation of private businesses in R&D, insufficient budgets and often uncertain commitments of the national government. Large philanthropic funders like B&MG, Wellcome, a large variety of non-profit organisations, as well as the World Bank have tried to address the issue with very visible policies such as the Centres of Excellence (more prominently that of the World Bank and of AESA), DELTA and CARI. Ironically, these same initiatives tend to proliferate and even risk a certain scattering of pockets of larger resources.

There is little understanding of the effect of those large initiatives, on equilibriums between various actors (policy entities, performing institutions, private and public sector...) and the proliferation of funding might appear as a new source of inequality among rich and poor partners.

Our review has also provided evidence of a changing geography of research for development, with the appearance of Chinese partnerships, the rising prominence of Morocco, the increasingly central role of Kenya (especially in central and eastern Africa) and the continuing scientific consolidation of South Africa's position on the continent. But we still have little empirical evidence on the role of incentives in knowledge production, on the way policies directly affect careers, the staffing of public institutions and enterprises, on the circulation of talent, as well as the use and investment of financial resources in research. Even the necessary articulation of national (or local) relevance and international excellence, as well as the intermediating role of funders, are rarely addressed within clear analytical frameworks. We require more precise studies on scientific migration and mobility, on the effects of funding on careers and employment and on the relation between policy (when it increases available funding for research) and employment. The political economy of research in Africa appears very sketchy and incomplete and needs to be actively investigated.

Position any new initiative in an already very populated world of initiatives

We signal the emergence of a new institutional framework in Africa, where governments in many countries establish national authorities in charge of science and technology (Ministries, councils, funding agencies), sometimes with the support of the World Bank, AfDB or foreign funding agencies; where S&T policies are defined concretely and operationalised. A non-exhaustive list, apart from the particular case of South Africa, could mention Kenya, Tanzania, Namibia, Ethiopia, Ghana, Senegal, Burkina Faso...).

At the level of institutions, there is some recognition of the need to have more strategic research policies – see for example DRUSSA³⁶ programme that has had some impact in providing emphasis on universities developing research management and uptake strategies. Moreover, universities are now often defining international strategies to support the academic development, as well as consolidating their “third-mission” activities (that is beyond teaching and research), which in Africa should be a major activity. Research universities are slowly emerging as the major players in research in Africa.

Thus, the governance of funding systems is also very much part of this effort to define an increase in research activities and better policy-making. Policy-making at the national level is more often using international collaborations, including co-operation with foreign partners such as the European Union to modify profoundly their funding practices. The striking example of Egypt’s reform of the science policy is very impressive. When creating the new STDF (science and technology development fund) that introduced competitive calls for research, Egypt was also creating a management structure at the Ministry of Higher Education and Scientific Research that was based on a large fund provided by the EU. This management and policy unit has been instrumental, and curiously was set-up before the revolution of 2011. It survived the revolution, as well as the further political change that was experienced by that country. Something similar happened in Tunisia, although we believe that the policy changes that allowed the reinforcement of the research were largely defined prior to the 2011 Revolution (M’henni & Arvanitis, 2012). The EU considers PASRI, a programming experiment on science technology and innovation in Tunisia that was funded by the EU, as a success, but it very much relies on an already existing structure that has been very resilient politically.

The effect of restructuring and strengthening of the research management systems because of multilateral and bilateral agreements also seems to take place in the Southern African Development Community (SADC) under the increasing influence of the South African NRF and national organisations in Uganda, and Kenya, but also concerns smaller countries.

But the main challenge is the heavy reliance on foreign funding, countries and universities alike, for their research effort. This makes the definition of one’s own research policy or research strategy quite difficult. Moreover, levels of employment in research are still low, although they are probably growing and will continue to grow, depending on structural economic conditions and legal constraints (immigration policies, etc...).

Any new funding initiative should be careful to be different from the on-going programmes. It should be constructed with a strong local management and scientific partnership that involves strong African institutions in order to have the legitimacy necessary to avoid the risk of a neo-colonial situation. The EU has had a major experience with creation of the PRIMA initiative and some lessons should be drawn with African partners based on this experience.

Some cautionary notes on funding excellent individuals, but with active supportive functions: examples of IFS and ERAWIDE

The Abidjan Call is asking to create an African Research Council; it should be quite clear from this paper, that many assumptions concerning the way research functions in Europe *are not valid in Africa*. We would like to insist on one *major* difference (among many other): careers in African research institutions can rarely be exclusively research-oriented. Even with individuals very strongly committed to research, with strong training in research (which also means they have had extended

³⁶ Development Research Uptake in Sub-Saharan Africa (DRUSSA) was a five-year, DFID-funded programme supporting 22 Universities across Africa to strengthen the management of research uptake. It ran from October 2011 to September 2016. The purpose of DRUSSA was to help improve the capacity of universities to contribute research evidence in pro-poor policy and practice. DRUSSA achieved this through sharing learning on institutional change and research uptake strategy,

supporting training of university staff in research uptake and communication, and through facilitating and strengthening networks between DRUSSA universities, other research management bodies, external stakeholders and research users, including policymakers. <https://www.acu.ac.uk/focus-areas/research-management-uptake/drussa>

training with foreign partners in foreign countries), the actual functioning of institutions will necessitate to take into account needs other than those of research only. Two different activities are undermining the time a professor at the university can dedicate for research: teaching loads and consultancies. Both should be taken into account by any future funding scheme, knowing none can be avoided. As far as consultancies are concerned, they can serve the purposes of research, if (and only if) they are recognised by the academic institution.

To our knowledge there exists only one example of funding in developing countries that is directed to individuals based on excellence and high quality new researchers, located in their own country and not necessarily based on North-South partnerships. It is the experience of the International Foundation for Science (IFS, see above). An important aspect of the success of IFS might have been the fact that the relatively small grants are surrounded by additional activities or funding (equipment, organisation of workshops in specific topics that are interesting a large number of grantees, etc...). In other words, IFS does not make any assumption that the local socio-economic context will be helpful, thus providing support to its grantees that researchers in Europe would find in their own institutions and social environments.³⁷ Moreover, funding for individuals should not create a situation of an autonomous structure of the funded project inside its host institution, functioning as a “parasite” cell in the academic organism. Projects should be, on the contrary, a

way of enhancing the training for research, and management of research projects for the university. Specific arrangement, of course could be valid experiences, by an appropriate recognition by the host institution.³⁸ Here the individual grant should be explicitly used in order to fund the *formation or consolidation of a local team* with the possibility of a relatively small grant. The European Commission has some scattered experience of such funding under FP7 (e.g. projects ERAWIDE in the Mediterranean region, Pancera et al., 2013).

A last provision would be that the funding should not necessarily be a collaboration project with a Northern partner—rather the projects could be or not collaborative. This provision would make a difference with the funding delivered by practically all foreign funders. In such a programme, not necessarily geared toward “partnerships”, all the typically complicated relations between North/South PIs, lead/co-lead would fall. That should permit also to emphasize the necessary integration to international research networks without the patronage of a Northern partner.³⁹

Finally, the management structure, in all the funding initiatives we have reviewed, is of paramount importance. The team of the management structure should be in phase with the grantees and understand the management and practical aspects as well as the scientific challenges,⁴⁰ thus creating strong confidence linkages between programme managers and scientists.

³⁷ This configuration (small grants and support functions) is not exclusive to IFS, see for example the French CORUS programmes to French-speaking African countries, Madagascar, Senegal, Cameroon and Burkina Faso (Bolay & Michelon, 2009; Hamelin & Huber, 2009). Incidentally, the Evaluation report of CORUS programme insists on the necessity to support “valorisation of the research” and “interaction with users” as well as “a better insertion in international networks”.

³⁸ Interestingly, the Egyptian experience of the RDI office for managing research projects at the Ministry of Higher Education and Research (based on European funds) could be seen as a unique experiment of good practice. Documented in K. Papageorgiou’s Background report on Egypt for MENAFUND project (Arvanitis et al., 2014) (Egypt report available upon request).

³⁹ IDRC managed such a programme, Research on Knowledge Systems (RoK) at the beginning of the millennium (Graham, 2006). The programme also gave insights

on public-private partnerships (Graham & Woo, 2009) and formed the basis of the thinking of IDRC today in partnerships, that is reflected in its participation in the Science Granting Councils initiatives as well as in its analysis of the changes in research systems (O’Brien & Arvanitis, 2018).

⁴⁰ Research management offices are becoming more frequent in research universities and face a large variety of tasks (Botha & Hunter-Hüsselmann, 2016). In the Arab countries (Africa and Middle East) TEMPUS, now ERASMUS Plus programmes have been instrumental in consolidating the research management functions in universities. In Africa, there is no equivalent programme and it seems that INCONet type projects (like CASSNET-Plus) have not explicitly discussed this aspect. When talking science policy, in the EU-Africa dialogue, universities do not appear as a major player.

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