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Draft White Paper on Science, Technology and Innovation neglects to prioritise issues of performance and human capability

The release for public comment of the Draft 2018 White Paper on Science, Technology and Innovation[1] marks the culmination of a lengthy internal process within the Department of Science and Technology (DST). As noted in the Minister's Foreword to the Draft White Paper, the document is intended to replace both the 1996 White Paper on Science and Technology[2] and the 2008 Ten-Year Innovation Plan[3]. Its publication is the outcome of a strategic project initiated and driven several years ago by the then Minister of Science and Technology, Naledi Pandor, which has involved several cycles of input from members of the DST and its associated entities, such as the National Intellectual Property Management Office and the National Advisory Council on Innovation, and wide consultation with external experts and consultants.

Inevitably, although the draft document is relevant and broad-ranging, it carries the scars of this consultative process. There are inconsistencies (e.g. the use of terms for human development), there is a lack of detail in certain key areas (e.g. public sector innovation and new funding sources) and there is an impossibly long list of policy interventions (26 policy intents and 340 policy actions/sub-actions). (These numbers were obtained by coding the relevant chapters with ATLAS.ti and then manually filtering the coded quotes to remove statements about the future without reference to a specific action.)

Of greater concern, however, is that the document fails to ignite a convincing sentiment that science and technology can indeed contribute to the solution of South Africa's social and economic challenges. In our opinion, the following are needed to strengthen the weaknesses, before finalisation of the document:

- a clearer articulation of, and strategy for, the development of human capability and its link to economic development;

- a more critical perspective on the institutional reform, particularly public research institutions, as a means of raising the productivity of knowledge production;

- a greater emphasis on policy experimentation as a channel of transformative change, the latter in the interests of inclusivity and sustainability;

- a definitive statement on how funding will be increased and to what extent; and finally

- a much more direct list of interventions linking science and technology to economic growth and employment (i.e. a clearer and more logical theory of change), which highlights the importance of technology transfer.

More details on each aspect are given after the general overview.

General overview, core objectives and policy shifts

The core theme of the document is the accelerated deployment of science, technology and innovation (STI) in the pursuit of greater inclusivity, transformation and development, captured by the vision of 'science, technology and innovation enabling sustainable and inclusive development in a changing world'[1]. In order to achieve this vision, the DST, it is proposed, will adopt a general approach of expanding what has worked, proposing new approaches where necessary, taking advantage of opportunities presented by megatrends and promoting inclusivity and transformation.

In broad terms, these statements are irrefutable as strategies, but empty on important detail. The latter is partly contained in the more specific sections and policy proposals covering, for instance, how public institutions will be transformed or how STI will be used to accelerate economic growth. In our analysis of whether the proposed instruments adequately address the objectives, we have constructed a classical policy matrix, as shown in Table 1.

The matrix allows for a more detailed critique of objectives versus instruments. The latter are categorised into the three-fold typology of regulatory instruments, financial and economic instruments, and soft instruments, which are referred to as the 'sticks, carrots and sermons' of public policy.[4] This typology, which allows for the grouping of policy instruments into a limited number of well-defined categories, has been effectively applied to innovation policy as a means of understanding and designing suitable policy mixes.[5]

It is apparent from the matrix that the objective of 'policy coherence and coordination' overwhelms all other priorities, with implementation relying on the soft instrument of intra-government coordination, consultation and planning processes. The more critical objectives of enhancing economic growth, developing human capability and improving funding are mentioned less frequently, and sustainability is almost completely neglected. Table 1 and its analysis support our listing of the main policy gaps.

Table 1: The policy matrix of the Draft White Paper, constructed using the conventional categories for policy instruments[5]

| Policy objective	Policy instrument										
	Regulation			Economic transfer				Soft instruments			
	Review intellectual property rights	Reform institutions	Adapt other legislation	Change funding allocation	Use public procurement	Invest in human capability	Incentivise other investment	Encourage collaboration	Plan and consult	Effect intra-governmental coordination	Monitor and evaluate
Human capability development			1	5		18		5		8	2
Greater inclusion and transformation	3			9		8	2	4	3	5	1
Sustainability			1	5					1	1	
Enhanced economic growth		3	6	23	4	2	2	4	5	6	
Improved partnerships (NSI)		2		10	2	1	2	19	11	12	
Policy coherence and coordination	1	3	3	6	3	3	1	7	29	38	14
Performance (of public institutions)		3		3			2	4		5	5
Expanded NSI and research enterprise		2		19	1	1	1	3	5	5	1
Enabling innovation environment	4		6	15	2		1	1	6	6	1
Public sector innovation								1		2	
Improved NSI funding regime			1	15	5		4	2	13	10	2

Note: The table lists the number of times that a particular policy objective is mentioned in the form of a specific policy action. In the construction of the matrix, we considered both the explicit objectives in the Draft White Paper as well as two implied objectives, namely sustainability and public sector innovation. We have omitted policy instruments that occur fewer than eight times, as well as cases in which the nature of the instrument is not clear or in which there is no obvious link to a policy objective. Some planned policy actions support multiple objectives, and some implement more than one policy instrument. The 99 sub-actions identified were not included in this analysis; only the 340 policy actions were tabulated.

Policy gaps

Human capability

Despite being acknowledged over a long period as being a core weakness, the necessary development of human capability in South Africa remains unrealised.[6] Although the Draft White Paper has a chapter on human capital, its placement in the document and its title should be changed, reflecting not content editing but a performative and semiotic imperative. Human capability is fundamental – not only to economic growth, but also for the materialisation, at the level of the individual, of ethical values, citizenship, and specific goals of pursuit which align with principles of social and environmental justice.[7]

The benefits of human development are well illustrated by a comparative study of post-Soviet Baltic, Central Asian and Transcaucasian states. Lithuania in particular is a post-Soviet success story, driven by a high level of human capability which remained in place after the collapse of the Soviet Union. Already in 1994, the country had a literacy rate of 99%, but by 2016 more than 60% of the population had a post-secondary qualification, as shown in Figure 1.
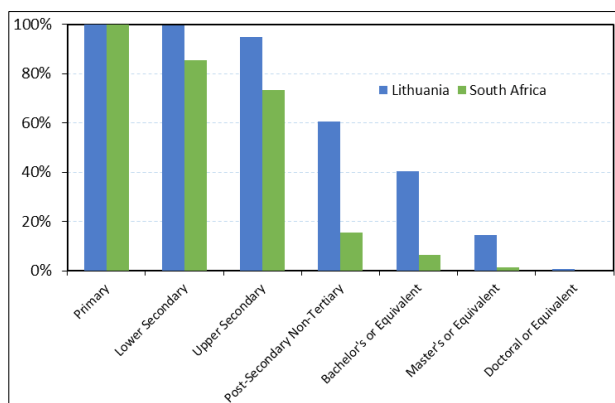
Source: OECD[30]

Figure 1: Education attainment levels in Lithuania and South Africa, 2016.

In combination with higher levels of gross expenditure on research and development, this emphasis on human capability development has had a radical impact on economic development and per capita income, as shown in Figure 2.
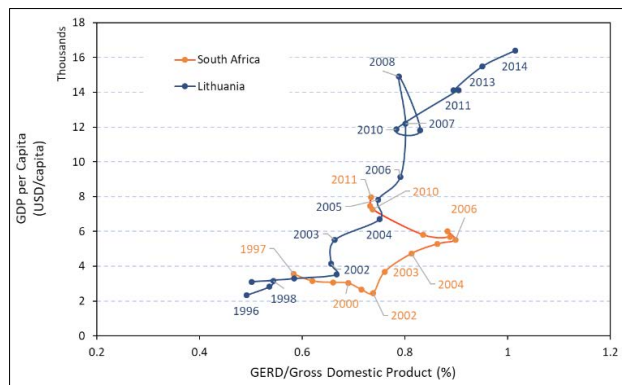
Figure 2: Gross expenditure on research and development (GERD) and per capita income for South Africa and Lithuania, 1994 to 2016.

The Draft White Paper employs a confusing medley of terms relating to human development. Our view is that all references to human resource development (used 19 times) and human capital (used 8 times) should be replaced; these terms are narrow and neglect the real importance of human development, and particularly post-secondary education. As a policy document, the White Paper needs to set a new precedent in terms of how education is conceptualised, and hence how the roles of public educational institutions are defined. In particular, the development of human capability at post-secondary level should be identified as the first and most urgent priority.

Management of higher education and public research institutions

The development of the Draft White Paper has been preceded by an impressive number of studies and reports[8-13], most of which have recommended the transformation of public sector innovation-linked institutions. The Draft White Paper has responded to these recommendations through a number of broad policy proposals, including the establishment of an Inter-Ministerial Committee on Science and Technology, revision to the mandate of the National Advisory Council on Innovation and strengthening the governance of public research institutions.

In our view, these proposals are vague and non-committal. The intentions of reform are limited to reducing overlap and inefficiencies, and even expanding the number of institutions. A recent review of public-funded research and development (R&D) highlighted the poor performance of the science councils and the intramural government research institutions relative to the universities as producers of many forms of research and

innovation outputs, including scientific publications, patents, spin-off companies, contract research income and research qualifications.[13] The review adopted an approach which monetised the various types of outputs and then calculated an overall return on investment from the public funding, the results of which are shown in Figure 3. It was concluded that the universities, as presently configured and assessed, represent the most attractive return for public funding.[14]

Concerns have already been raised about the high cost and low output, relative to their mandate, of the science councils[12], suggesting a much more radical approach to the restructuring of public research institutions, including the following:

- closure of the Human Sciences Research Council, with its core units being moved to the universities or, in the case of the Centre for Science, Technology and Innovation Indicators, to the National Advisory Council on Innovation;

- separation of the National Facilities (essentially performance agencies) from the National Research Foundation (a funding agency), and the general integration of such facilities where long-term capital investment is required; and

- separation of the funding and performance arms of the Medical Research Council, with the funding portfolio being moved to the National Research Foundation.

We agree with the Draft White Paper intent of the development of a policy framework to 'describe the purpose, functions and governance of public research institutions', and feel that this aim should be undertaken as a matter of urgency. A critical component of this framework should be the clear definition of the rationale for public research institutions, to allow for the more efficient allocation of government's research needs, in cases in which capital-intensive research infrastructure is not required, from science councils to the universities.

Policy experimentation and policy mix

Policy mix and policy experimentation have emerged since the publication of the 1994 White Paper on Science and Technology as important developments in the field of innovation studies. Experimentation in innovation policy recognises that the national system of innovation (NSI) is a complex system, and that policy outcomes are often uncertain, especially in developing countries.[15] Experiments permit the exploration of new approaches, particularly in addressing wicked or intractable problems, in a dynamic and positive style, supporting the principles of reflexive governance and enabling the establishment of niches which can be scaled to broader programmes more reliably.[16-18]

Similarly, the rationale for considering policy mix, rather than individual policy instruments, is several-fold; in the first instance, policy beneficiaries are diverse and require different approaches to achieve
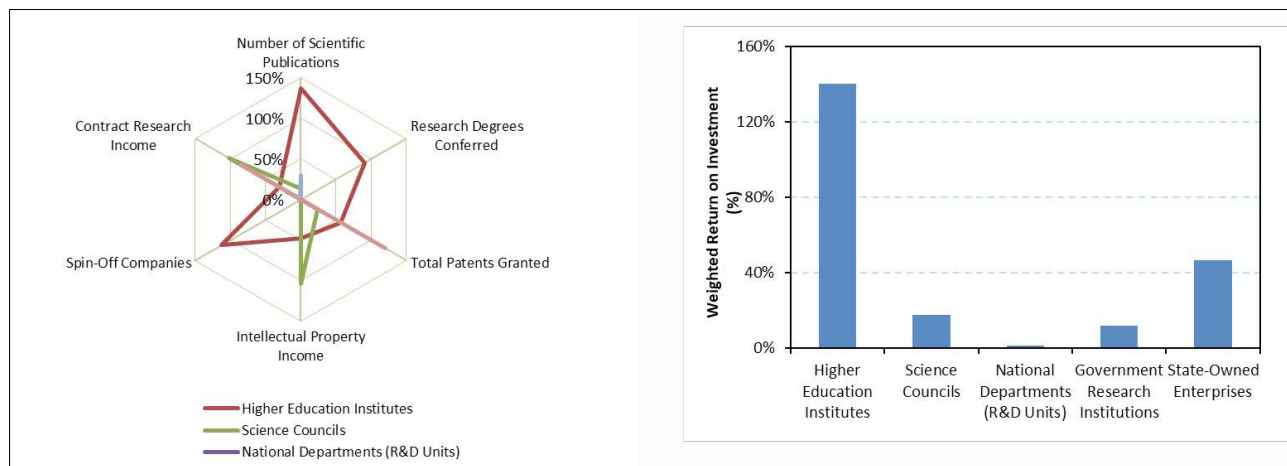
Figure 3: Comparison of the outputs from public-funded R&D at public institutions.

similar outcomes.[19] Furthermore, policies themselves interact and are interdependent, requiring a more holistic approach to policy design and analysis.[20] It is argued that a policy mix approach is particularly important in addressing the objectives of socio-technical transformation and sustainability transitions[21], both of which are core intents of the Draft White Paper. In our own research, we have shown that South Africa's innovation policy mix is dominated by supply-side measures, supporting early stage R&D but providing more limited assistance for market development.[19] Rebalancing the innovation policy mix towards the use of more demand-side instruments (such as the use of public procurement as a means of stimulating innovation), combined with generic rather than population targeted policies, as shown in Figure 4, could improve policy outcomes.
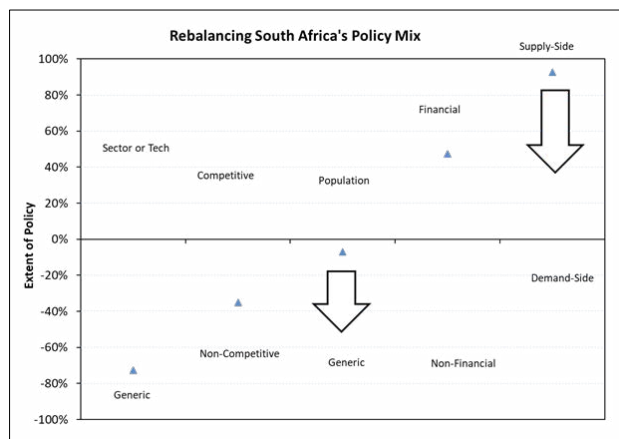
Source: Naidoo[19]

Figure 4:   Recommended adjustments to South Africa's innovation policy mix.

It is our view that the DST is missing an opportunity to mainstream policy experimentation and mixes in its Draft White Paper. A specific section in the document covering the importance of both approaches as a means of addressing the considerable and intractable system problems, such as innovation-led economic growth, would be invaluable in both introducing these methods as legitimate processes within government, and also to improve upon the document's underlying theory of change.

Indeed, in its present form, there is no explicit theory of change. Although some of the specific policy intents are linked to the desired outcome (e.g. the establishment of the Inter-Ministerial Committee on Science and Technology as a means of improving policy coherence), the overall theory is not stated, nor is it apparent in the overview material. Policy experimentation itself assumes a particular theory of change, namely that such experiments lead to broader systemic change as a consequence of scale-up from the niche (micro) level to new regimes and eventually new landscapes.[17] It is also more amenable to implementation, which, as we know, requires the synchronicity of an acknowledgement of the problem, the existence of an appropriate policy and acceptance by politicians of the proposed policy solution.[20,22] Experimentation allows implementation to proceed even if there is still some doubt about the immediate prospects of a solution.

### *Economic growth led by technological change*

The award of the 2018 Nobel Prize for Economics to Paul Romer, in acknowledgement of his work on endogenous growth theory, further strengthens claims of many economists and innovation theorists that economic growth is directly linked to technological innovation.[23] Romer[24] noted that the important sources of economic growth are technological change and increases in 'human capital', which are in turn driven by intentional investment decisions in R&D and other sources of innovation.

This insight was derived from data in developed countries and should be mediated by the South African context in two respects. Firstly, the most important path for technical change in developing countries is technology transfer and diffusion, broadly described as innovation by 'doing, using

and interacting (DUI)'[23]. Secondly, the two important determinants of successful DUI are a strong absorptive capacity within the business sector and public research institutions, and high-level policy support for technology transfer.

Absorptive capacity depends on a complex set of antecedents including the two important supply-side factors of human capability and public-funded R&D, and the three demand-side elements of legitimacy, local market and entrepreneurial activity.[25,26] The Draft White Paper implicitly acknowledges the important role of public-funded R&D in stimulating economic growth, and the now widely accepted perspective that such R&D has a higher level of return than private R&D[27], so long as knowledge systems are sufficiently open to ensure knowledge diffusion and economic spillovers.

As a result, the Draft White Paper highlights the need to expand present levels of funding but fails to indicate how this expansion can be achieved under the present economic conditions of contraction and fiscal restraint. Targets for gross expenditure on R&D are frequently not met and have been described as 'wishful thinking'[28]. South Africa is no exception, having consistently failed to meet its own intensity goals.[10] In a climate of many competing priorities, it is difficult to imagine how additional funding will be secured, but it is our opinion that government needs to lead the trend through reprioritisation of existing budget allocations. There is precedence, even in South Africa, for a more expansive role of the state in R&D; a longitudinal study of historical expenditure has shown that in 1964, public funding of R&D accounted for 80% of the total expenditure (Figure 5). Although the context is very different, it could be argued that government R&D funding in 1964 enabled the country's subsequent high rate of economic growth.
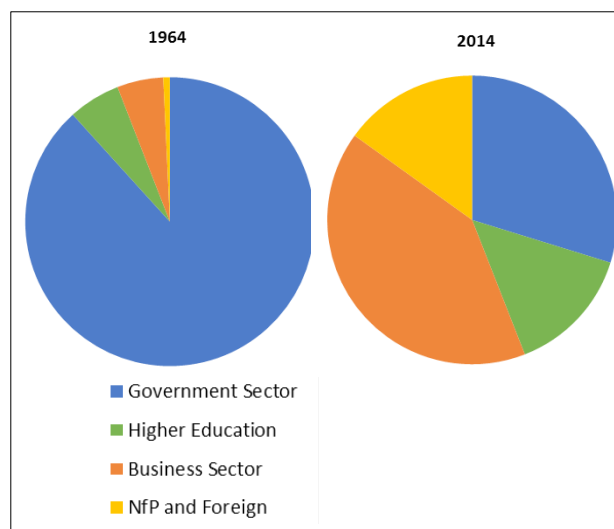
Source: Van Wyk et al.[32]

Figure 5:   Profile of R&D expenditure in South Africa by source of funds, 1964 and 2014.

In terms of high-level support, the Draft White Paper does seek to include such a goal, and hopefully it will find a stronger reception than in previous administrations. In this area, South Africa should learn from China's science and technology policy, which has over a long period advocated and implemented a highly proactive role for the state in technology transfer and R&D as the starting point for its innovation-driven development and economic growth strategy. Indeed, China's approach to science and technology has been unequivocal and completely unambiguous. For instance, on many occasions, President Xi Jinping and his predecessors have stressed the importance of innovation in economic growth, declaring that 'innovation is the most powerful lever for development' and the need to 'strive for both scientific and technological innovation, and institutional innovation … to fully unlock our development potential'[29].

Discussion and conclusion

The challenges of policy processes are considerable. Policy should be consulted, not just in the interests of democracy and participation, but also to ensure alignment, policy coherence and stakeholder support, and to avoid any disastrous, unintended consequences. However, consultation may lead to a dilution of focus, a lack of clear prioritisation and the rallying of resistant elements which can impede system-wide necessary change. Important aspects of effective policies – such as being able to reallocate resources and to effect the necessary transformations – can be annulled by consultative processes.

We argue that rationalisation of the policy actions through a clearer theory of change is essential. In this respect, the NSI approach may have outlived its usefulness. Its adoption as a guiding framework for innovation policy in South Africa was a political, not a technocratic, perspective. The approach relied upon an ambitious level of agency at the micro (or individual) level, and a high level of efficiency at the meso (firm and government department) level. Agency depends on human capability which, as reported in many studies, is an area in which South Africa generally fails dismally. Moreover, meso-level performance is patchy in both public and private sectors, with the last decade of state patrimonialism being disastrous for South Africa's economy and the NSI.

In the absence of widespread agency and efficiency, the NSI framework may not be a sufficiently radical approach to achieving the broader goals of the Draft White Paper. In our view, although the application of the NSI framework has, so far, been insightful and constructive, and there is now a broader consensus within government about innovation-led growth, the framework's political assumptions are too conservative about the role of its actors, and could be changed to the more experimental but transition-based approach of the multi-level perspective.[17]

Our core advice to the policy architects is to abandon the more generic platitudes of NSI theory and to strengthen the institutions (used in the sense of laws, regulations and codes) and organisations of the state in their role as agents for innovation and technology transfer. Make human capability development the top priority, close non-performing science councils, ensure the clear separation of funding and performance mandates, and institutionalise policy experiments as a means of achieving transformation, inclusivity and sustainable development. In this way, the comments of the Deputy Minister in her Foreword to the Draft White Paper may indeed be prescient:

> *I am confident that through efficient implementation of this new STI policy by various stakeholders in the public and private sector, the lives of our people and the fortunes of our communities will be transformed through STI.*

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