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POLICY MIXES AS A MEANS OF OVERCOMING CHALLENGES TO INNOVATION IN DEVELOPING COUNTRIES; INSIGHTS FROM A MIXED METHODS STUDY OF SOUTH AFRICA'S MANUFACTURING SECTOR

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Abstract

Although the discipline of innovation policy is well established and extensively presented in the literature, policy mix as an analytical framework and particularly its application to developing countries, is largely neglected. In this study, a mixed methods approach has been followed in order to initially profile the policy mix in South Africa and then develop an understanding of how innovation policy mix, as a component of industrial policy, could be rebalanced, and hence made more effective, in addressing the requirements of the manufacturing sector. The characterisation followed the typology as used by the Organisation for Economic Cooperation and Development in order to allow a cross-case comparison with two other countries (India and Canada), and the use of data from the research and development tax incentive scheme. This analysis has concluded that, post-1994, South Africa's policy mix has been dominated by supply-side measures to which firms have responded with varying levels of enthusiasm. Rebalancing the innovation policy mix towards the use of more demand-side instruments, particularly for emerging industries, combined with additional effort at marketing these programmes to struggling industries, could address weaknesses in the manufacturing sector and improve its overall prospects.

Keywords: Innovation Policy Mix; Developing Country; Demand-Side; Supply-Side; Manufacturing

About the Author

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Abbreviations

DST	Department of Science and Technology
dti	Department of Trade and Industry
GDP	Gross Domestic Product
ICT	Information and Communication Technologies
IPAP	Industrial Participation Action Plan
R&D	Research and Development

Preamble: Personal Reflections on Industrial and Innovation Policy since 1994 (In the Post-Modern Tradition)

My first exposure to industrial policy was in 1996, when I spent a year working at the Department of Trade and Industry (dti). The work involved establishing the Directorate for the Chemical Industry and introducing a set of initiatives to support downstream chemical manufacture, but more importantly for this article, I also spent many hours as an official at the Board on Tariffs and Trade (BTT), debating matters relating to tariff adjustments, protection of local industry, and dumping duties.

At the time, the economy was highly concentrated. Only three conglomerates (Anglo-American, Sanlam and Old Mutual) controlled 75% of the total capitalisation of the Johannesburg Stock Exchange; it truly was an era of white monopoly capital. From my perspective, the industrial policy regime of the pre-1994 era was driven by the desire to ensure white consumers in South Africa and the apartheid state had access to the goods and services which they needed within a climate of increasing isolation from the global economy and trade sanctions.

This policy focus was reflected in the daily operations of the BTT prior to 1994. Large companies wanting to grow their manufacturing businesses in plastics, textile, rubber products and other products, regularly brought applications for tariff protection to the BTT, and such protection was readily granted. It is also true to say, however, that in 1996 we had industries. Manufacturing at that stage contributed 22% to Gross Domestic Product (GDP), and South Africa had expensive operations in textiles, footwear, leather goods, bags, clothing, pulp and paper, and metal products, much of which has since disappeared entirely or at least weakened. As we all know, manufacturing is now only 13% of GDP (as of 2018).

The BTT and others state institutions changed quickly post-1994. Although this perspective has not been widely reported, my experience of industrial policy in 1996 was that its underlying objective was to break up the conglomerates, reduce tariffs as a means of bringing new players (especially black entrepreneurs) into the downstream industries, and make the economy more competitive. Tariffs were reduced to 50% of their previous levels over a period of 3 to 5 years, and new applications or protests by the large companies were largely ignored or granted only in part.

Since 1996, there have been many other changes. For instance, by 2016, Anglo-American's share of market capitalisation on the JSE had shrunk to as low as 15%, and black ownership has increased substantially. But two important aspects have not changed; although there has been some growth in high-value sectors of manufacturing, we remain substantially dependent on primary production, and the economy is an environmental problem, some would say disaster.

It was the latter issue that led me back to industrial policy in 2014. I became interested in the general topic of sustainability transitions and how this could be enabled through policy instruments. It was clear from the 1996 experience that the policy environment in South Africa had become diverse, with a range of instruments across different sectors, but with a strong supply side focus. The shocking revelation from the 2014 work, however, was that private firms had apparently failed to grasp the shift in focus, and hence benefit from the newer instruments. Their mindset seemed to have adapted only very slightly to the revised policy approach, with the result that firms were struggling to remain or become competitive, except in those sectors such as automobiles, where demand side measures were still dominant. It was this realization that led to the outline of this research and paper.

1. Introduction

The revitalisation of manufacturing, which persists as a highly desirable desired outcome of South Africa's industrial policy, remains elusive. Innovation policy, which forms a small but important component of broader attempts to diversify the economy and build higher value adding sectors, has also had relatively little impact, despite being part of the policy environment for more than two decades. In this respect, innovation-led growth, particularly in manufacturing, has consistently under-performed relative to the achievement of the cohort of countries within which it has become fashionable to bracket South Africa.

The importance of technological innovation and its role in social development have been highlighted over a long period, and more recently in the 2019 State of the Nation Address by President Ramaphosa, who stated:

> *"Revolutionary advances in technology are reshaping the way people work and live. As a young nation, only 25 years into our democracy, we are faced with a stark choice. It is a choice between being overtaken by technological change or harnessing it to serve our developmental aspirations. It is a choice between entrenching inequality or creating shared prosperity through innovation.*
>
> *Unless we adapt, unless we understand the nature of the profound change that is reshaping our world, and unless we readily embrace the opportunities it presents, the promise of our nation's birth will forever remain unfulfilled. Today, we choose to be a nation that is reaching into the future. We see a country that has embraced the benefits of technology for economic growth, social development and for more effective governance. We are producers of knowledge and drivers of technological progress."*

Such statements create large expectations of the science and technology actors, including the Department of Trade and Industry (dti) and the Department of Science and Technology (DST). These actors have responded to the challenge in a number of ways, including the introduction of a number of white papers, strategies, and action plans. This article considers to what the instruments which were specifically designed to support innovation in the economy, have failed or succeeded in their objectives, and what lessons can be extracted from the path of industrial reform which has been followed over the last 25 years. The intention of the article has been to briefly review the historical shape of innovation policy, and how this has changed. It then covers the response of the manufacturing sector, or at least a small portion thereof, to the new policy environment. Finally, the article concludes with a discussion on the implications of the research for future initiatives within innovation policy.

2. Overview of Trends in Innovation Policy

2.1 Innovation Policy in South Africa

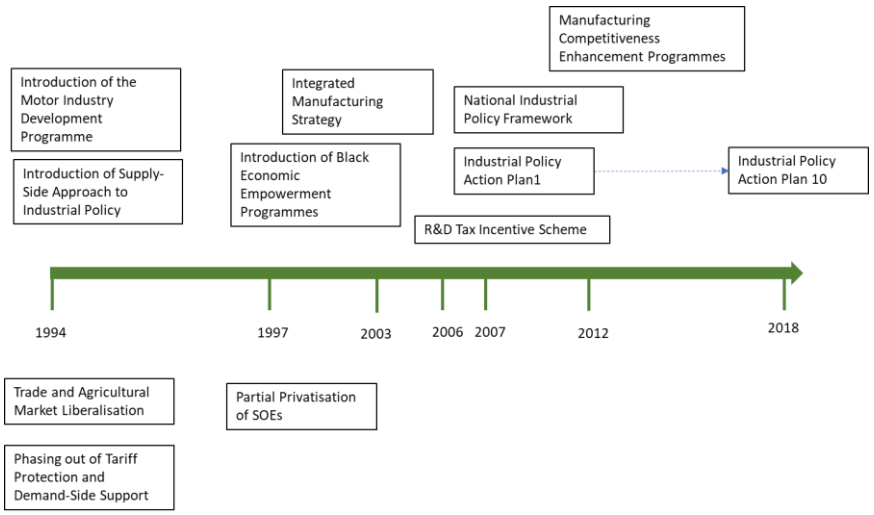
There is no specific innovation policy in South Africa, although there are documents covering research and development (R&D), science and technology (S&T) and industrial policy. There is also not a strong record of academic critiques of the country's innovation-related policies, with 2 to 3 articles per year over the last 25 years. Interestingly, there are even fewer such critiques of industrial policy and the area has, in the main, been guided and managed by practitioners.

The separation of R&D, S&T and innovation is a complicated exercise and often ignored by the literature. Their resultant conflation creates unnecessary confusion and makes the analysis of the separate policies more difficult. In this article, the terms are applied in their strict sense, and as far as possible, the discussion on innovation policy is separated from S&T or R&D. Moreover, it is assumed that within a policy hierarchy, innovation policy is a component of industrial policy, notwithstanding the simplification which this implies and the much narrower application of innovation policy than may be typically applied. In this sense, innovation policy is conceptualised as one of many supply-side or demand-side instruments which can be used to stimulate industrial development, alongside policies for preferential procurement or human resource development or financial support.

It is also assumed that industrial refers mainly to manufacturing. In other words, industrial policy in this analysis covers those policies aimed at stimulating the manufacturing base of an economy including all components of secondary and tertiary production. Such policies have existed in various forms since 1994, but were formalised in 2007 with the introduction of the National Industrial Policy Framework (NIPF). This framework was supported by the subsequent Industrial Policy Action Plans (IPAP), published on an almost annual basis over the last decade. 'Innovation and technology' were specifically listed in the NIPF as their own strategic programme (SP8), which supports the earlier assumption of innovation policy being a subset of a broader set of policies.

The evolution of industrial policy has been previously documented (Maia, 2019; Bam and De Bruyne, 2018; Barnes et al., 2017; Zalk, 2014); a high level timeline is shown in Figure 1. Since 1994, its development has reflected a dominance of the supply-side approaches, which were introduced in the early 1990s and have persisted ever since, although presently within a broader spectrum of policies. The immediate focus was trade liberalisation and manufacturing competitiveness, resulting in a steep reduction in import tariffs and the introduction of instruments to support investment in infrastructure, human resource development, upgrading of capital equipment, private R&D and technology transfer.

Figure 1. Industrial policy development in South Africa since 1994

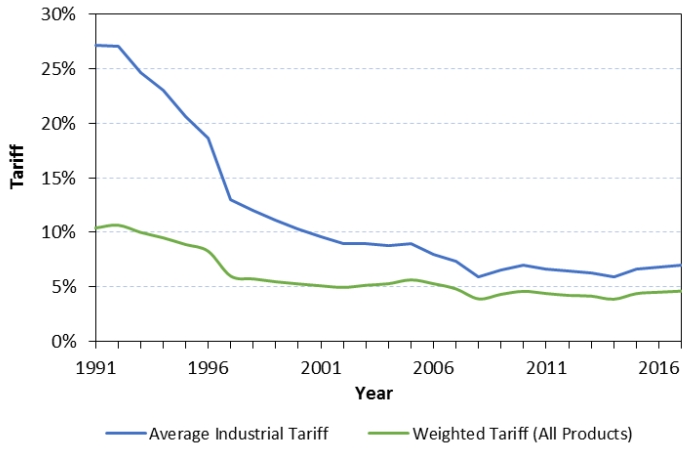


Source: Maia (2019)

The tariff reduction was perhaps the most significant indicator of the new approach, falling from 27.5% in 1990 to about 8% in 2006 and 5% in 2016 as shown Figure 2 (Zalk, 2014). Changes to the tariffs were driven by the agreements reached at the conclusion of the Uruguay Round, which were

signed in Marrakesh (!) in 1994, where South Africa resolved to reform and simplify its tariff structure, and to reduce the actual ad-valorem duties over a twelve-year phase-down period. Some of the end rates have remained high (the effective rated duty rates on cars, light vehicles, and minibuses is still at the high level of 34% and the duty on original motor parts is 20%). The Marrakesh Agreement included the General Agreement on Tariffs and Trade (GATT), along with agreements concluded during the Uruguay Round.

Figure 2. Average tariff levels in South Africa; 1991 to 2017



Source: Zalk (2014); World Bank Database

Although it has been argued that trade liberalisation has resulted in limited export growth (Edwards and Lawrence, 2008), the overall impact of the new policy environment for manufacturing has been devastating. Since 1994, the contribution of manufacturing to Gross Domestic Product (GDP) has hardly changed, from R341 billion to R387 billion (indicate values in real terms), despite an overall 2.8% p.a. growth in the economy (1994 to 2018). As a result, the proportional contribution has dropped from 21% to 13.2%.

Interestingly the performance of the different sub-sectors has been highly variable, with the worst performer being 'textiles, clothing, leather and footwear', whose output has declined by 40%. On the other hand, the best performing sub-sector, 'motor vehicles, parts and accessories', has grown by 150%.

The data presents a number of interesting hypothesis for industrial policy analysts. Although not the only sub-sector to receive such support, the automobile manufacturers have benefitted from high tariff duties and a dedicated manufacturing incentive. In other words, demand side measures build manufacturing output, although the cost has been considerable. For instance, it is estimated that the dti's assistance to the automotive industry has cost R5 billion a year, mostly in the form of savings on duties and taxes i.e. indirect, financial assistance (TIPS, 2018).

The second hypothesis relates to those sectors which have grown despite tariff reform and trade liberalisation, for example basic chemicals, chemical products, glass products, beverages and paper products. These high growth sectors are characterised by a number of attributes, including elements of market protection due to poor or limited mobility of the products, such as packaging materials which have a high volume to value ratio, strong domestic demand over the study period, and a greater willingness to adopt supply-side support in the new 'liberalised' environment. The response of firms to the policy changes is a core issue in the analysis of this article and is discussed in more detail in Sections 4 and 5.

It is also hypothesised that the high-growth sectors responded more actively to the policy environment, including innovation policy. Sectors which were exposed to a sharp increase in international competition and which were traditionally not supply-side structured, meaning that their costs were driven by their inputs of primary raw materials and low-skilled human resource, such as footwear and clothing, declined sharply in manufacturing output.

It is the latter hypothesis which leads to a more detailed discussion of innovation policy. The latter is primarily a supply-side measure, although there are examples in some countries of innovation-driven procurement policies (Edquist and Zabala-Iturriagagoitia, 2012). Importantly, the balance between supply-side and demand-side is a dimension of the methodology of the Organisation for Economic Cooperation and Development (OECD) for the profiling of innovation policy, indicating that it plays an important role in the general success of innovation policies.

The state of innovation, and the extent to which policy has influenced the level of technological innovation within private firms in South Africa, has been irregularly covered in the literature. Since 1994, there has been only a single innovation strategy, namely the Ten Year Innovation Plan (Department of Science and Technology, 2008), and several reviews (Naidoo, 2016; Hart et al., 2013; Kahn, 2013; Kaplan, 2013; OECD, 2007). The most extensive, although not the most recent, review was undertaken by the OECD in 2007; this study identified human resources as a key constraint to the innovation system and advocated a knowledge-intensive strategy as an important solution to problems of poverty and unemployment (OECD, 2007). It also recommended strengthening the governance structure of the innovation system and adopting a broader approach to innovation, which would ensure that private firms received more recognition as the primary drivers of innovation-linked economic growth, and more public support for firm-level innovation.

Two OECD-style innovation surveys have also been completed since 1994, based on the format as outlined in the Oslo Manual and the general approaches of the OECD countries (Moses et al., 2012). The 2008 survey concluded that South African firms have a relatively high rate of innovation and novelty, although these assertions were later challenged by other researchers (Kahn, 2013; Ministerial Review Panel, 2012). In particular, it was noted that the country's commitment to economic diversification, innovation systems and knowledge-led growth was more rhetorical than substantive, and that despite the theoretical approach of its economic and industrial policy, it had remained mostly an extractive economy driven by supply-side measures "consistent with the linear model of innovation" (Kahn, 2013 p 207).

The latter criticism raises the question of the extent to which policy makers have acknowledged the issue of system complexity and the need to multiple instruments, interacting within a policy mix framework. This issue is discussed in the next section.

2.2 Trends in Policy; Emergence of Policy Mix

The design of innovation policy, not as a collection of individual instruments, but rather as a portfolio of instruments which mutually interact and require attention to cohesion, alignment and mutuality, is a relative new approach within the policy field.[1]

[1] It is noted that much of the data and discussion in this paper has been derived from a published mini-dissertation (Naidoo, S. (2016)) and a separate article which has been approved for publication, but not yet published, in the African Journal of Science, Technology, Innovation and Development (Walwyn, D. and S.

Although there are many definitions of policy mix in the literature, this article draws on the approach of Flanagan et al. (2011), which defines policy mix as a combination of policy instruments that interact to influence a desired outcome. The study of such mixes includes the analysis of the processes by which such instruments emerge (Rogge and Reichardt, 2016); the objectives of the overall policy; the nature of the interactions that result in the effectiveness (or destructiveness) of the combined instruments; and the dynamic or temporal nature of the policies (Schmidt and Sewerin, 2018).

The actual profile of the innovation policy mix is generally described using a typological framework which allows for the grouping of instruments into a limited number of well-defined categories. Various approaches have been adopted in terms of this typological framework. For instance, Borrás and Edquist (2013) adopt a three-fold typology, namely regulatory instruments, financial and economic instruments, and soft instruments, which are referred to as the "sticks, carrots and sermons" of public policy (Bemelmans-Videc et al., 2003).

Other typologies include those developed by the Organisation for Economic Cooperation and Development (OECD, 2012) and Cunningham et al. (2013). The former adopts a number of dimensions to describe each instrument, namely whether the instrument is aimed at a specific population (such as pharmaceutical firms) or can be applied to all sectors; whether the funding is direct (such as a grant) or indirect (such as a tax credit); whether the instrument is a demand-side (market protection) or supply-side (R&D grant) intervention; and whether application for the funding follows a competitive process (such as a research fund) or is granted based on a set of qualification criteria (see Table 1).

Table 1. OECD typology of innovation policy instruments

Type of Instrument	Description
Population targeted versus generic instruments	Population targeted instruments are aimed at specific sectors, or specific types of firms, especially SMEs or technology based firms
Technology targeted versus generic instruments	Technology targeted instruments favour specific types of sectors or technology. Examples of sectors and technologies favoured by technology-targeted instruments are renewable energy, biotechnology and additive manufacturing.
Financial versus non-financial instruments	Non-financial instruments are instruments that do not involve the exchange of funds, but are based on other benefits. Examples of such benefits may include access to infrastructure, training, information or markets.
Direct versus indirect financing instruments;	Direct financing instruments include instruments such as loans, grants, repayable advances and innovation vouchers. Indirect financial instruments include instruments such as tax incentives for innovation activity.
Competitive versus non-competitive instruments	Competitive instruments allocate funding based on the evaluation of competitive proposals against a set of criteria, with allocations based on the quality of the application and the available funding.

Supply-side versus demand-side instruments	Supply-side instruments focus on the generation of knowledge, while demand-side instruments incentivise the growth of market opportunities to increase the demand for innovation

Source: OECD (2012)

The rationale for considering policy mix, as opposed to individual policies, is several-fold; in the first place, firms are highly heterogenous, requiring different forms and levels of support depending on their sector, their maturity, the way in which they absorb technology, and their geographical context. Secondly, policies themselves interact and show levels of interdependence which influence their impact (Flanagan et al., 2011). Finally, different policies are often hosted by separate government departments whose policy objectives may not overlap or even act in conflict.

The debate on alignment and coherence also raises another important question which is the evolutionary nature of policy environments. Policy mixes are rarely the consequence of portfolio design in which a government will *ab initio* establish a national policy mix through purposive action and co-ordination (Flanagan et al., 2011). Mixes are emergent processes which exhibit a high level of pathway dependency. It is indeed this aspect which make the discussion on policy mix so important; countries need to continuously assess the policy portfolio to ensure that it remains broadly coherent and relevant to the innovation context.

The common qualitative and conceptual approach to studies of policy mix designs has been criticised as being too subjective to properly inform policy design and strategies to address policy weaknesses (Schmidt and Sewerin, 2018; Howlett and Del Rio, 2015). As a result, recent work has focussed on developing quantitative assessments of policy mixes based on the two dimensions of policy intensity and technology specificity which are combined into a single Index of Policy Activity (Schmidt and Sewerin, 2018). The latter is then used as the independent variable to profile the dynamic or time-based changes in policy mixes, and hence to understand how design and mix can be optimised in order to achieve a specific transition.

Notwithstanding this development in policy mix studies and the overall need for a more generalised theoretical framework, this study has adopted the OECD approach to the characterisation of policy mixes, with the exception that actual expenditure data has been used to show policy emphases, rather than the opinion survey approach of the OECD.

3. Data Gathering and Analysis

The optimisation of innovation policy mixes, as a means of addressing the gradual failure of the manufacturing sector, has been a subject of research by the author over a period of about four years. In a 2016 study, exploratory-sequential method (Creswell, 2013) was followed in order to firstly characterise South Africa's policy mix relative to two comparator countries, and then determine how firms were responding to the policy environment (Naidoo, 2016).

In this phase, a quantitative analysis of the utilisation of the R&D tax incentive has been undertaken as an independent confirmation of the results from the first study. No additional primary data has been collected; the analysis has depended on secondary data published as part of the incentive's annual reports to Parliament (Department of Science and Technology, 2019; Department of Science

and Technology, 2017). The reports cover the scope and output of the programme since its establishment in 2006, including the legislative mandate, the objectives, applications received, the throughput of applications processed and the profile of approved applications. Since its launch, the programme has supported over 1,000 companies, and approved a total of R46 billion in eligible R&D expenditure, resulting in foregone tax revenues of about R5 billion. The reports form a rich database of the response of firms to the incentive.

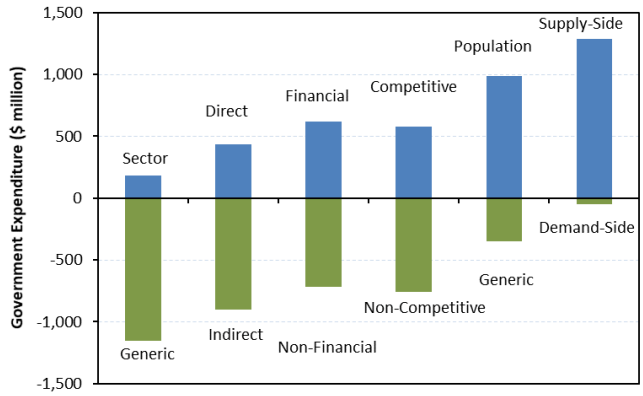
4. Results

4.1 Innovation Policy Mix

In the 2016 study, the full range of innovation policy instruments were listed and the budgets extracted from national budget data, as published by the South African Government (National Treasury, 2015), and the annual reports of each department. Based on the objectives and funding mechanism for each instrument, the budgets were then allocated to the respective OECD categories as defined in Table 1, from which it was possible to calculate the total allocations and hence the relative policy weightings.

The results of the analysis are shown in Figure 3, from which it is apparent that the policy mix is heavily weighted towards supply-side instruments and population-specific schemes.

Figure 3. South Africa's innovation policy mix (total public expenditure)



Source: Naidoo (2016)

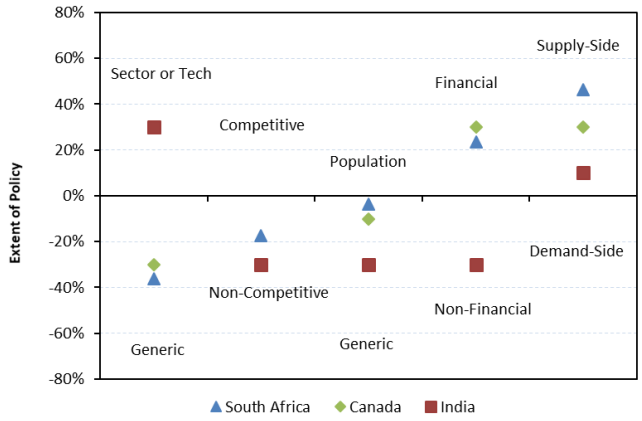
There is no formula for the prescribed shape of policy instruments as a function of the state of industrial development within a single country. Each country has its own set of instruments which form a unique combination, reflecting both local contexts and the pathway dependence of policy frameworks. As a result, it is not possible to deduce from the OECD profile whether the present policy mix does or does not suit the economic environment within South Africa.

Nevertheless, it is possible to infer possible deficiencies by comparing the profile against that of comparator countries. In this study, Canada and India were chosen as examples of a developed and developing country respectively. The data for these countries was obtained from the existing publicly available databases as reported by the Innovation Policy Platform (World Bank and OECD, 2017), although it is noted that the values were obtained through the standard OECD method of opinion surveys rather than actual expenditure data, as for South Africa.

The comparative information is shown in Figure 4. The most obvious differences are in the three categories of supply vs demand side, technology-specific vs generic, and financial vs non-financial

instruments. Using the framework of the OECD typology, developing countries such as India tend to favour demand side, non-financial and generic (rather than technology-specific) measures. South Africa's profile appears to be closer to the Canadian policy mix, which would be inappropriate given the present challenges in the country, and the need for niche-type experimentation with new industries.

Figure 4. Innovation policy mix comparison between countries



Source: Naidoo (2016), World Bank and OECD (2017)

4.2 Perception of Innovation Policy Instruments

The 2016 study also investigated the experiences of a sample of firms in the defence industry with innovation policies, the analysis of which revealed several insights about the perceived availability and coverage of such instruments (Naidoo, 2016). Although there was overall a highly positive response to the R&D tax incentive scheme, several companies expressed the view that the instruments were not well publicised and as a result there was under-utilisation of the available support.

> *"Communication of the instruments is a hurdle. Not everyone is aware of it. I know I mentioned that my background is defence manufacturing, but I also got a little bit of exposure into mining equipment manufacture. From the dti cluster meetings that I sat in, very few, especially the smaller companies have visibility or awareness of the policy instruments that are available although they could probably benefit the most. "*

> *"Innovation policy as a whole... If we were aware of the opportunities for funding… Communication would be the biggest impact. Inform us what options there are and what avenues there are and secondly relieve us of the bureaucracy. That in itself will allow us to focus on innovation rather than compliance."*

Those companies which were accessing policy instruments were frustrated by the level of administration which was required in order for funds to be approved.

"You cannot believe that one person can generate so much paper. And the dti just does not respond. Five Years. Five years, that's what it takes. We applied for R2.5m. We wanted to put a bunch of machines in here, wanted to really upgrade. Eventually we got R530k five years later. It's so frustrating, it's unbelievable."

"I think that the biggest stumbling block was the administration, so I think that it needs to be a lot clearer in terms of what the requirement is…"

There was also the sentiment that government employees (policy makers) had little understanding of the commercial space and hence developed instruments which had little value to them.

"People who make decisions on behalf of business haven't the slightest clue what it takes. They don't understand. The people who make the policy decisions should actually interact with business. And I'm talking about the people at our level. Have people empowered and knowledgeable develop the policy."

The conclusion of this work was that the impact of the instruments was variable between the companies, with only some companies reporting good knowledge, understanding and use of the various incentives. In order to understand this aspect in more detail, and in particular to determine which factors were important in shaping the firm-level response, it was decided to look at more specific quantitative information from the R&D tax incentive scheme. This work is now described.

4.3 Sector-Level Response to the Policy Incentives

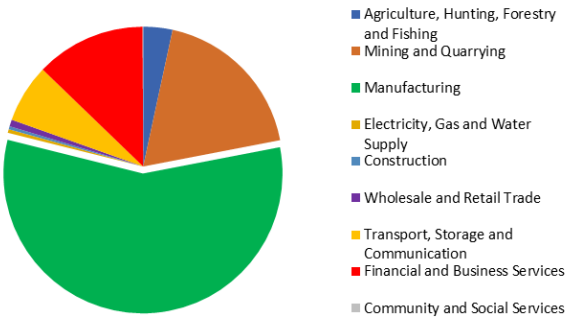
The factors that determine the extent of a company's absorption of new knowledge and subsequent innovation in response to competition is a well-studied topic (Bento and Fontes, 2015; Chang et al., 2013; Goedhuys and Veugelers, 2012; Chan et al., 2008; Cohen and Levinthal, 1990). The absorptive capacity of a firm depends on multiple factors including a firm's openness to external knowledge, the depth of its internal expertise, the strength of its networks, the attitude of its management and its relationships within global value chains (Walwyn et al., 2015). Prior work in the foundry industry has shown that a positive attitude within firms towards new knowledge should not be assumed; some firms purposely adopt an isolationist approach on the assumption that openness exposes company expertise to its competitors, and new technology is too risky or too expensive to implement.

Policy changes invoke a similar set of responses; firms are either suspicious of the new instruments and reluctant to engage with them, or more enthusiastic about new possibilities that such policy changes may reveal. In order to get some understanding of the nature of firms which have responded to the R&D tax incentive, data from the annual report of the scheme to Parliament was analysed (Department of Science and Technology, 2019).

The scheme was introduced in order to encourage private sector R&D investment in South Africa. The incentive allows companies to deduct 150% of R&D expenditure incurred from their income, thereby reducing their tax liability and recovering 14% of their qualifying R&D expenditure. As such, it is an indirect measure to assist companies in building their innovation capabilities through the development of R&D programmes and projects. Several studies in the literature have supported the efficacy of such schemes, and particularly the important role that internal R&D can play in building absorptive capability (Cirera and Maloney, 2017; Hall et al., 2010).

Data from the tax incentive scheme shows that the sectoral distribution of companies which have successfully accessed the programme is highly variable; the manufacturing sector accounts for 57% of the total approved funds of R20.6 billion over the period 2012 to 2018, despite contributing only 13% to GDP, as shown in Figure 5. On the other hand, business services, which contributes 22% of GDP, accounts for only 13% of the approved funds. The extremely low level of participation from firms in the electricity, gas and water sector is also noteworthy.

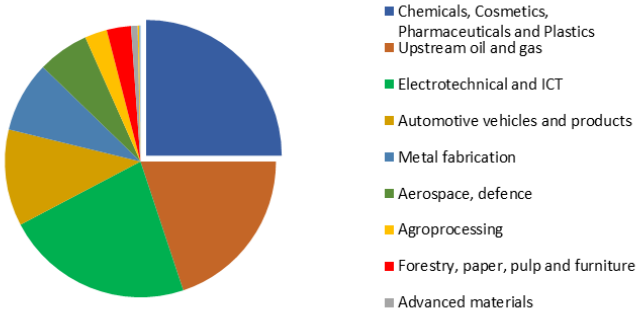
Figure 5. Approved R&D expenditure on the R&D tax incentive programme; 2012 to 2018



Source: Department of Science and Technology (2019)

Even within manufacturing, there is also a diversity of activity, as shown in Figure 6. The largest user of the scheme, as measured by approved applications, is the sub-sector of chemicals, cosmetics, pharmaceuticals and plastics, accounting for 25% over the history of the scheme, followed by upstream oil and gas, electrotechnical and ICT, and then automotive firms.

Figure 6. Approved R&D expenditure by IPAP sector; 2006 to 2018



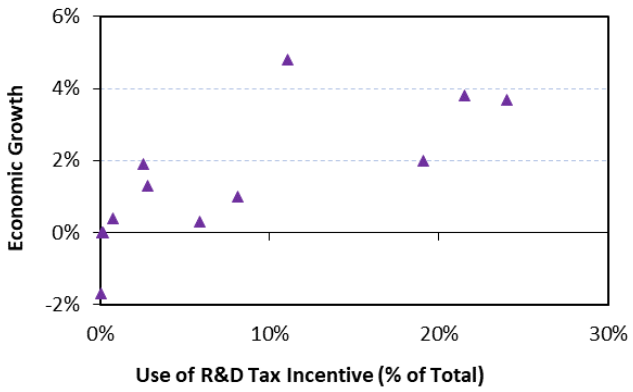
Source: Department of Science and Technology (2019)

The data will require further research in order to fully understand the reasons for the low participation by some of the sub-sectors such as agroprocessing. R&D intensity is itself highly variable and does not correlate with company revenues or even sectoral GDP. However, it is interesting that sub-sectors which have grown appreciably over the period of the tax scheme (2002 to 2018), have grown more strongly in terms of GDP contribution, as shown in Figure 7. The correlation of this graph should not be interpreted as causative since it is not supported by studies which may or may not confirm the standard requirements for causation including time-order, clear rationale and the absence of spurious factors. Clearly there is some co-variation, but higher

economic growth may itself result in higher levels of R&D expenditure and hence more active engagement with the R&D tax incentive scheme.

R&D investment by business enterprises declined in real terms since 2008, a trend which has been raised as a concerning issue for policy efforts to re-industrialise the country (Walwyn and Cloete, 2016). It is precisely this trend which the R&D scheme is positioned to reverse or counteract, and it is inferred from Figure 7 that the scheme is indeed having some effect in supporting ongoing R&D efforts within several of the key IPAP sectors. Although figures for the R&D intensity of firms within the leading sub-sectors have not been extracted, it will be interesting to check whether there is an element of additionality i.e. the scheme has attracted additional R&D expenditure rather than replaced existing intra-firm resources. This question has been previously debated and contested within the literature.

Figure 7. Sub-sectoral economic growth and use of the R&D tax incentive; 2006 to 2018



5. Discussion

At the beginning of this article, it was noted that manufacturing data by sub-sector presented two hypothesis relating to the varying growth across the sector, namely that the success of the automotive industries relative to other sub-sectors could be the result of the retention of a strong demand side measures in this industry, and secondly that the success of other high growth industries could be explained by the willingness of the respective firms to understand and benefit from the new supply side instruments.

Although neither hypothesis have been tested in a rigorous quantitative study, the initial insights from the studies described in this article indicate that both hypotheses could be supported. It is without doubt that the policy context has changed significantly since 1994, and that this change has impacted significantly on the manufacturing sector in South Africa. In particular, innovation policy as a component of industrial policy has become central to the maintaining or re-establishing the competitiveness of local industries. Firms which have been exposed to international competition through the dilution of import duties, and which have not responded to the new innovation policy instruments, have been left behind by the changing context, and have either disappeared or are disappearing. These results call for a new approach towards innovation policy mix, including the use of stronger demand side measures, as is being used in other countries, as a means of rescuing struggling manufacturing sectors (Walwyn and Cloete, 2018). Although the use of public sector procurement as a means of achieving higher levels of industrialisation was initially slow to start, the localisation of procurement is now a large part of public procurement including products from the

designated industries. Local supply to public programmes is estimated at R865 billion over the period 2019 to 2022 (Maia, 2019), and will provide a significant incentive to local companies.

The study on policy mix suggests that innovation policy in South Africa requires some rebalancing if it is to be more effective in building the key sectors as identified by IPAP and other development plans. In particular, demand side approaches should be increased, together with more non-financial measures and less emphasis on specific sectors or technologies.

6. Conclusion

Innovation policy is considered to be fundamental to industrial policy, and particularly to a country such as South Africa which is struggling to diversify its economy and achieve higher levels of economic growth through the development of knowledge intensive, high value-added manufacturing sub-sectors. In this respect, the analysis of the country's innovation policy, and an understanding of how the present instruments achieve, or fail to achieve, their targets is important to the goals of industrial policy.

The country has, by the standards of a developing country, a complex set of instruments which cover a broad range of firm-level priorities. However, the analysis as described in this article, which uses policy typologies and phenomenological approaches to understand how firms experience the policy environment, and how they have responded, has shown that only certain sectors are managing with any degree of competency the policy hiatus which occurred after the signature of the Marrakesh Agreements. In the post 1994 period, it appears that firms that have adapted to the supply-side focus have traditionally understood the importance of intra-firm absorptive capacity, and the importance of innovation as a means of remaining competitive.

The relative success of these firms and the automotive sector, which has retained its demand side instruments over this period despite the tariff agreements pertaining to other sectors, suggests two important results from this study, namely that emerging industries should be protected with a strengthening of the demand side measures, such as through the use of the provisions for designated industries, and that more effort should be made to advise companies of the existing supply side instruments, such that their use becomes more efficient and more widespread.

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