European Commission

Specific Support to Tunisia

Research priorities and private participation in R&D

Horizon 2020 Policy Support Facility

Research and Innovation

Specific Support to Tunisia – Research priorities and private participation in R&D

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Specific Support to Tunisia

Research priorities and private participation in R&D

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LIST OF ABBREVIATIONS

ANPR	National Agency for the Promotion of Scientific Research
APII	Agency for the Promotion of Industry and Innovation
BMN	Industrial Capacity Upgrade Office
CEO	Chief Executive Officer
CNEARS	National Committee for the Evaluation of Scientific Research Activities
DG RTD	Directorate-General for Research and Innovation
EC	European Commission
FDI	Foreign Direct Investments
FTE	Full-Time Equivalent
GDP	Gross Domestic Product
GERD	Gross Domestic Expenditure on R&D
HE	Higher Education
ICT	Information and Communication Technologies
IPR	Intellectual Property Rights
IRESA	Institution of Agricultural Research and Higher Education
MDIC	Ministry of Development and International Cooperation
MHESR	Ministry of Higher Education and Scientific Research
MoF	Ministry of Finance
MoI	Ministry of Industry
NIS	National Innovation System
PIRD	Grant for investment in research and innovation
PNRI	National Programme of Research and Innovation
PPP	Public-Private-Partnerships
PRF	Projets de recherché fédérés (Federative Research Projects)

PSF	Policy Support Facility
R&D	Research and Development
R&I	Research and Innovation
STEM	Science, Technology, Engineering and Mathematics
TLC	Telecommunications
TND	Tunisian Dinar
TTO	Technology Transfer Office
UI	University-Industry
UTICA	Tunisian Union of Industry, Trade and Handicrafts

THE PSF SPECIFIC SUPPORT PANEL

Philippe Busquin, *Chair*, was European Commissioner for Research from 1999 to 2004 and Member of the European Parliament from 2004 to 2009 for the French Community of Belgium and sat on the European Parliament's Committee on Industry, Research and Energy. Mr Busquin was the Chairman of the Science and Technology Options Assessment Panel. He was also a substitute for the Committee on the Environment, Public Health and Food Safety and a member of the Delegation to the EU-Russia Parliamentary Cooperation Committee

Alessandro Muscio, *Rapporteur*, is Associate Professor in Applied Economics at the University of Foggia (Italy). He specialises in innovation policy, technology transfer, university-industry interaction. Alessandro is National Expert in the programming committee of Horizon 2020, designated by the Italian Ministry of University and Research (MIUR). Alessandro was a Science & Technology Policy Specialist at Technopolis Group, UK Office, and a research fellow at the Science Policy Research Unit (SPRU, University of Sussex, Brighton). As part of his professional activity he was involved as national expert in the initiative Regional Innovation Monitor Plus (RIM Plus), sponsored by the EC DG Enterprise and Industry / DG Regional policy, and in several evaluations of European-wide and nation-wide research and innovation policy schemes and industrial analyses. Alessandro has an extensive track record of publications on research and innovation in international scientific journals.

Hannes Leo has been analysing various dimensions of innovation activities and innovation policy for more than 25 years and has co-founded *cbased* (Community Based Innovation Systems) which provides policy advice, organises participatory decision-making processes and launched discuto.io. He has been responsible for large-scale research and policy consulting projects (e.g. Competitiveness Report of DG Enterprise, Sectoral Innovation Watch (Europe Innova). Hannes is member of the Team of Specialists on Innovation and Competitiveness Policies (TOS-ICP) at UNECE, delegate to the European Economic and Social Committee (EESC) and was a visiting researcher at the University of Rome, the Science Policy Research Unit (SPRU, University of Sussex, Brighton), the Office of Telecommunications (OFTEL, London) and the University of California at Berkeley.

Katrin Milzow is Head of the Strategy Support Division at the Swiss National Science Foundation (SNSF), where she has been working since 2008. She coordinates strategy and planning processes and provides advice for positioning on strategic issues (e.g. impact of research, responsive vs. proactive funding, evaluation processes, Open Science). She has played a leading role in developing an output monitoring system for the SNSF and is responsible for risk management, compliance and internal controls.

Florent Olivier is expert in social co-building processes and priority setting in the higher education, research and innovation field. He is currently working for the French Ministry of Higher Education, Research and Innovation, in the department in charge of scientific strategy. He was responsible for the consultation, priority setting and validating process for the Research National Strategy (SNR, 2015), and for the convergence of other national strategies with

it, among them the national higher education strategy, energy, health, sustainable development and scientific culture strategies. He is now working on the implementation and developing tools for the future evaluation of this strategy in a quality process.

Teresa Diez Iturrioz, *Peer Expert*, Cabinet of the Secretary of State for Research, Development and Innovation, Spain.

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The project was overseen by the PSF Team in the EC's Directorate-General for Research and Innovation. Roberto Martino coordinated the exercise and liaised with the Tunisian authorities. The PSF contractor supported the EC's PSF Team in this activity. This involved work by Bea Mahieu, project manager at Technopolis Group, Jari Romanianen, who acted as the quality reviewer, and Soheir Dani, who prepared the background report based on a structure proposed by the rapporteur and then revised based on comments from the experts' team.

The Tunisian authorities provided available data and background documentation useful for the panel's work, and also supported the visits to Tunisia (i.e. inviting the representatives of government institutions and stakeholders; providing meeting facilities, as required). The Ministry of Education and Science provided coordination support to the Tunisian authorities, ensuring the involvement of other relevant ministries, agencies or bodies.

SUMMARY AND POLICY MESSAGES

This report has been produced at the request of the Tunisian authorities by an expert panel funded under the European Commission (DG RTD) Horizon 2020 Policy Support Facility. It is based upon a background report, document analysis as well as interviews with key stakeholders conducted during two country visits by the panel in the course of 2018. The Tunisian government expressed interest in receiving support on two specific topics:

- **The definition of research priorities** – This was aimed at effectively combining the bottom-up consultation process with top-down priorities, ensuring both the appropriation of the strategic focuses by research and innovation (R&I) stakeholders, and smart specialisation towards areas of greatest relevance for Tunisia scientific capacity and economic development.

- **The promotion of private participation in research and development (R&D)** – The panel was asked to analyse and formulate recommendations on the governance and instruments needed to better valorise research results by creating stronger public-private cooperation and further stimulating private investment in R&I.

The expert panel identified the following three key policy messages that underpin the more detailed recommendations presented in the report:

1) Set up the right conditions for enabling effective R&I policy development;

2) Strengthen synergies and coordination across R&I stakeholders and funding flows around well-selected priorities;

3) Foster the engagement and performance of all key operators of the innovation ecosystem through well-designed incentives and support tools.

We propose 13 specific issues grouped into these three themes. For each issue, we summarise the rationale underpinning it, followed by the detailed recommendations. We also set out the **operational steps** required and time frame for implementation in Table 1.

Theme 1: Set up the right conditions for enabling effective R&I policy development

1. Extend the scope of the national R&I strategy beyond R&D policy

Tunisian R&I policy design tends to divide research policy from innovation policy, with a strong emphasis on supporting research activities. The research system specialises in basic research activity.

- We recommend the extension of the focus of R&D policy to R&I policy. Besides supporting the research system, R&I policy should be broader in its scope, increasing support to business innovation that demands the contribution of researchers and establishment of collaborations with the research system.

2. *Improve exchange of information and coordination of strategy and policy at all levels*

Tunisia does not have an overall national R&I strategy. Coordination between ministries is improving, but there are challenges related to 'horizontal and vertical coordination' among different types of actors (e.g. between ministries and research institutions). The lack of coordination between the Ministry of Higher Education and Scientific Research and the Ministry of Industry has hampered the implementation of a coherent and systemic approach to R&I policy-making.

- The definition and coordination of national research priorities must be raised to an inter-ministerial level. An inter-ministerial committee should define and validate the necessary methodology and tools for the research priorities of the National Research Strategy, supervise its implementation and evaluation. National research priorities should also be inscribed in the five-year national plan.

- We recommend that all ministries directly or indirectly involved in R&I issues should contribute to the implementation of the National Research Strategy and its six priorities. Increasing collaboration, communication and coordination between ministries is a key step to increase efficiency in implementing priorities. The aforementioned inter-ministerial committee dedicated to R&I could contribute to the coordination of ministerial programmes and tools, focusing resources on priorities and optimising public expenses.

- We recommend the preparation and circulation of a consolidated budget for R&I activities, in order to increase the critical mass of research activity. The preparation of this document should provide the opportunity for the discussion of the ministerial research strategies and expenses, consolidating competitive research funding and enhancing the inter-ministerial coordination. This public document should be organised around the national research priorities to help to follow up the implementation of the national R&I strategy.

3. *Introduce data collection exercises to implement evidence-based decision-making in R&I policy*

Tunisia lacks statistics and data on R&I activity complying with international standards (e.g. the OECD Frascati Manual, 2002). Data on business innovation activity is limited and outdated and there is no data on the wider system of intermediaries. This is a significant obstacle in setting research priorities and in the realistic implementation of sector-specific intervention.

- At present, too many decisions in the area of R&I policy are based on the personal experience of policy-makers. Data from regular surveys should be used in R&I decision-making. Therefore, we recommend the creation of an information system regularly updated.

- We recommend the introduction of business innovation surveys such as the Community Innovation Survey carried out in EU Member States to be administered on a regular basis (e.g. every three years).

- We recommend yearly data collection exercises on the research system (laboratories and research institutions). These exercises should focus on capital and human resources, research funding and performance.

- We recommend that the system of intermediaries should be evaluated on a regular basis (e.g. every three years).

4. Provide training on strategy development to ministry staff

The majority of ministerial staff is not currently trained to implement a strategic approach in R&I policy-making.

- We recommend the promotion of training programmes for staff responsible for research programmes in all ministries and for managerial staff in research institutions on issues such as the strategic approach, evidence-based policy-making tools and the culture of evaluation/quality assessment.

- The training should be integrated into the priority-setting process (i.e. learning-by-doing with the support of an international consultant, international expert group, or some other suitable expert body).

Theme 2: Strengthen synergies and coordination across R&I stakeholders and funding flows around well-selected priorities

1. Better specify and implement research priorities in R&I policy

The Tunisian priority-setting process should focus research efforts towards socio-economic needs. The current priorities are topics of societal relevance, rather than research priorities. A more detailed analysis of Tunisia's challenges and a more explicit definition of how research could respond to these challenges would help in better defining the priorities and in increasing the effectiveness of R&I policy. Resources should be focused on areas in which problems match research potential, providing concrete opportunities for cooperation and allowing a clearer positioning of Tunisian research. The focus could be on socio-economic needs and/or key technologies.

- To specify the priorities further, we recommend the adoption of a problem-oriented approach, drawing on existing tools such as problem trees, logic models or value-chain analysis for an in-depth analysis of societal and industry needs, followed by a distinct analysis of research capacities. Building on this process, mission-oriented approaches or smart specialisation strategies can be gradually developed.

- The formal dialogue between stakeholders that started with the national consultation exercise in 2017 should continue. Informal fora should facilitate the priority-setting process, provide a basis for smart specialisation partnerships and stimulate the alignment federative research projects (PRF) on priority topics.

- We recommend the involvement of businesses in priority-setting exercises and in the identification of their demand for innovation. The focus should be on socio-economic needs and key technologies.

2. Consolidate national R&I funding focusing on the research priorities

The PRF scheme supports cooperation between multidisciplinary research teams and socio-economic stakeholders. The call for the PRF for 2017-2019 was exclusively limited to the six national research priorities. However, the number of funded projects is too low to have an impact on priorities implementation. Other ministries still define their funding allocation with temporary programmes.

- We recommend the consolidation of research funding on research priorities. Greater inter-ministerial coordination should ultimately help in consolidating funding from various ministries into a larger pot of resources supporting research projects on priorities.

- We recommend to maintain and reinforce the instruments available to the Ministry of Higher Education and Scientific Research to steer funds towards research priorities. A 10% bonus of the recurrent institutional funding was introduced in 2017 for laboratories and research units focusing on research priorities. This is a good practice that we recommend to maintain in order to push institutions to specialise and target their research activities.

3. Set up priority-specific networks bringing together relevant stakeholders

As part of the recent government exercise for the definition of research priorities, Tunisian authorities organised a consultation process targeted at researchers, administrative and technical management, representatives of relevant ministries, representatives of socio-economic organisations and of the civil society. However, not all relevant stakeholders were invited. In particular, the private sector feels that business needs are not fully accounted for in the definition of national priorities.

- We recommend the creation of knowledge-sharing networks between national stakeholders that are involved in specific research areas. These networks should facilitate the definition and implementation of national research priorities, the identification of critical areas, resources and capacities, and set the basis for the creation of research partnerships.

- We recommend that the Ministry of Higher Education and Scientific Research and the Ministry of Industry, together with the Tunisian Union of Industry, Trade and Handicrafts and the research community, should facilitate the creation of virtual communities based on implementation of the principle of Open Innovation, focusing on thematic areas and exploiting the support of the country's technopoles.

4. Coordinate national research funding with bilateral and European programmes

It is necessary to foster the coordination of national research funding with bilateral and European programmes, especially in the areas that match the Tunisian research priorities. This would greatly increase the critical mass of research funding in priority areas, increasing available funding for institutions that decide to specialise.

- While this is already in progress with respect to Horizon 2020, we recommend better coordination of research funding programmes from international sources and targeted applications for international funding opportunities.

- Gaps between important needs and capacities can be targeted by specific policies, such as attracting knowledge-intensive foreign direct investments and foreign researchers, or defining priority areas for new research labs, groups or laboratories, as well as international cooperation. The Tunisian DG for Horizon 2020 is already attempting to match European research funding opportunities to national research areas and priorities. This process could be key to address knowledge gaps in important areas for knowledge users.

Theme 3: Foster the engagement and performance of all key operators of the innovation ecosystem through well-designed incentives and support tools

1. Increase the accountability and autonomy of research institutions

Tunisia relies on a wide system of small research laboratories and units. Laboratories have limited research budgets and carry out all the administrative duties related to their research activities, responding directly to the Ministry of Higher Education and Scientific Research. Universities demand more strategic, financial and managerial autonomy, as well as leaner administrative processes. Their limited freedom is hampering research performance and third-mission activities. Some Tunisian universities benefit from the status of public institution of a scientific and technological nature (EPST), which grants more autonomy and encourages the adoption of a more strategic approach in universities' activities. It also sets the preconditions to align the research specialisation of institutions with the national research priorities.

- We recommend the simplification of procedures for the accreditation of the EPST status. At present the conditions for an institution to be eligible for this new status are, according to university stakeholders, hard to meet and the process takes too long.

- We recommend to increase the strategic and managerial role of universities, which should become accountable for the activities of their laboratories. This would increase their capacity to steer research efforts, alleviate the administrative burden of laboratories and increase the accountability of their activities with respect to academic engagement. Universities should also have more power in rewarding the best laboratories.

- We recommend that laboratories should report their activities to their parent university. Universities should aggregate information on laboratories and report it (be accountable for operations) to the Ministry of Higher Education and Scientific Research.

- We recommend the adoption of three 'wardship' tools (performance contract, mission letter and yearly target letter to the director) for autonomous institutions.

- We recommend that universities should promote mergers of laboratories to increase their minimum size to 50 full-time-equivalent researchers, in order to increase critical mass and accountability of their activities. This process should be carried out on a scientific basis, looking for potential complementarities between laboratories. Mergers could also be based on research priorities.

- We recommend more transparency in research evaluation and funding. The evaluation criteria used by the National Committee for the Evaluation of Scientific Research Activities are not transparent and the results of university assessments are not published. The criteria on the basis of which the evaluation of laboratories is done must be published. These criteria should also measure the institutional efforts in meeting research priorities.

2. Promote academic engagement with incentives and reforms

The researcher status in Tunisia is *de facto* a higher education teacher status, with no specific valorisation of other activities (research activity, expertise, international collaborations, partnerships with companies, start-up creation, third-mission activities). At present, there are no monetary incentives for researchers and/or labs to establish collaborations with the private sector.

- We recommend the introduction of the 'researcher status' in career evaluation describing clearly the main activities that characterise the work of this fundamental figure in R&I. Third-mission activities (e.g. patenting or university-industry partnerships) should also be considered in recruitment, evaluation and promotion criteria.

- We recommend the introduction of monetary incentives for researchers that cooperate with private sector. Research institutions should reward faculty members with monetary benefits for their licencing activity and for their commitment to collaborate with companies.

- We recommend reforming the country's IPR system in favour of the adoption of the 'professor's privilege' system, which would grant to academics the exclusive IPR to their inventions while granting some royalties to the parent institution.

3. *Increase the effectiveness of intermediary organisations in supporting R&I policy implementation*

The Tunisian R&I system is very complex, involving many actors. The system is undergoing rapid change, with several intermediaries being created (e.g. technopoles and technology transfer offices), but their human resources are too often very limited and not properly skilled.

- We recommend the adoption of a more strategic vision for the role of technopoles in the national innovation system. At present, they do not operate according to a given set of national research priorities nor to real industry needs.

- We recommend to professionalise the staff employed in technology transfer intermediaries. Proper investments in appropriate management and in skills development are needed if Tunisia wishes to maintain the current model of network of intermediaries. Technology Transfer Offices are often designed as 'empty shells' that do not contribute to technology transfer, offering no support to researchers on intellectual property rights and research commercialisation.

4. *Revamp existing programmes for innovation*

The evaluations of the two schemes 'Grant for investment in research and innovation' and 'National Programme of Research and Innovation' were rather critical concerning the overall design and implementation of these programmes. The objective of the latter is to encourage collaboration between companies and the public sector, but the way the programmes are structured reduces the potential benefits that mutual learning and knowledge transfer may accrue. Both programmes are characterised by substantial red tape, opaque application and evaluation processes.

- We recommend the extension of the role of companies in these schemes. The opportunities for them to lean from research institutions and technical centres should grow.

- We recommend to simplify application and evaluation procedures and make them more transparent. The evaluation should be carried out by independent experts.

- A method developed for start-ups should be used to deal with the inherent risks and uncertainties of creating new policy measures in Tunisia. We recommend the adoption of the 'lean start-up' (or lean innovation) approach, a purely data driven process that deals efficiently with uncertainties and tries to find solutions that work with as little resources as possible.

5. Increase absorptive capacity and promote entrepreneurship

Firms' human capital must be improved in order to address the problems of absorptive capacity and distance from the research community that characterise the business sector.

- In the attempt to increase the opportunities for university students to engage with businesses and for firms to access better educated human capital, we recommend to extend existing traineeship schemes to all university subjects. Traineeship schemes could also be based on real business problems/challenges and implemented by an interdisciplinary team of students under the guidance of the university.

- We recommend the involvement of representatives of the business sector and industry associations in the design and periodic evaluation of academic courses. This practice is common in several European countries, especially in high-tech sectors such as aerospace.

- We recommend the promotion of entrepreneurship education and R&D management courses for business representatives.

- We recommend the organisation of innovation challenges for master's degree students once a year, involving companies or professional associations (to define a thematic area and pay for the prize). Yearly contests could be created to support innovation and entrepreneurship for doctoral candidates. Those contests could be done in the area of the priorities.

- The Union of Industry, Trade and Handicrafts and the professional associations should promote the creation of discussions on the technological needs and of their members and invite the R&I system to respond to these needs, identifying potential areas of collaboration.

Operational steps and time frame for implementation

Table 1: Summary of recommendations

Theme 1: Set up the right conditions for enabling effective R&I policy development	
Extend the scope of the national R&I strategy beyond R&D policy	
Extension of the focus of R&D policy to R&I policy.	Starting now
Improve exchange of information and coordination of strategy and policy at all levels	
Raise the definition and coordination of national research priorities to an inter-ministerial level.	Starting now
All ministries directly or indirectly involved in R&I issues should contribute to the implementation of the National Research Strategy and its six priorities.	Mid-term
Preparation and circulation of a consolidated budget for R&I activities in the attempt to increase critical mass of research activity.	Mid-term
Introduce data collection exercises to implement data-driven decision-making in R&I policy	
Creation of an information system regularly updated.	Starting now
Introduction of business innovation surveys.	Starting now
Introduction of yearly data collection exercises on the research system.	Starting now
Evaluation of the system of intermediaries.	Starting now
Provide training on strategy-development to ministry staff	
Implementation of training programmes for staff responsible for research programmes in all ministries and for managerial staff in research institutions.	Starting now
Integration of training in the priority-setting process.	Starting now

Theme 2: Strengthen synergies and coordination across R&I stakeholders and funding flows around well-selected priorities	
Better specify and implement research priorities in R&I policy	
Continue promoting the formal dialogue between stakeholders initiated with the national consultation exercise.	Starting now
Stimulate the involvement of businesses in priority setting and in the identification of their demand for innovation.	Starting now
Consolidate national R&I funding focusing on the research priorities	
Adopt a problem-oriented approach to further specify priorities, considering the potential of research to contribute to specific issues.	Starting now
Coordinate research funding across ministries.	Starting now
Increase funding to research activities focusing on research priorities.	Long-term
Grant sufficient funding for research excellence in areas outside national priorities to allow new research directions and potential new national priorities to emerge and evolve.	Starting now
Maintain and reinforce the instruments available to the MHESR to steer funds towards research priorities.	Starting now
Set up priority-specific networks bringing together relevant stakeholders	
Creation of knowledge-sharing networks between national stakeholders that are involved in specific research areas.	Starting now
Creation of virtual communities based on the implementation of the principle of Open Innovation	Mid-term
Coordinate national research funding with bilateral and European programmes	
Better coordination of research funding programmes from international sources and targeted applications for international funding opportunities.	Starting now
Gaps between important needs and capacities can be targeted by specific policies.	Mid-term

Theme 3: Foster the engagement and the performance of all the key operators of the innovation ecosystem through well-designed incentives and support tools	
Increase the accountability and autonomy of research institutions	
Simplification of the procedures for the accreditation of the EPST status.	Starting now
Increase the strategic and managerial role of universities, which should become accountable for the activities of their laboratories.	Mid-term
We recommend that laboratories should report to their parent university.	Mid-term
Adoption of three wardship tools for autonomous institutions.	Mid-term
Universities should promote mergers of laboratories to increase their minimum size to 50 FTE researchers.	Mid-term
More transparency in research evaluation and funding.	Starting now
Promote academic engagement with incentives and reforms	
Introduction of the 'researcher status' in career evaluation.	Starting now
Introduction of monetary incentives for researchers that cooperate with private sector.	Mid-term
Reform the country's IPR system in favour of the adoption of the 'professor's privilege' system	Long-term
Increase the effectiveness of intermediary organisations in supporting R&I policy implementation	
Adoption of a more strategic vision for the role of technopoles in the NIS.	Mid-term
Professionalise the staff employed in technology transfer intermediaries.	Starting now
Revamp existing programmes for innovation	
Extend the role of companies in existing programmes.	Starting now
Simplify the application and evaluation procedures and make them more transparent.	Starting now

A method developed for start-ups should be used to deal with the inherent risks and uncertainties of creating new policy measures in Tunisia.	Mid-term
Increase absorptive capacity and promote entrepreneurship	
Extend traineeship schemes to all university subjects.	Mid-term
Involve representatives of the business sector and industry associations in the design and periodic evaluation of academic courses.	Long-term
Promote entrepreneurship education and R&D management courses for business representatives.	Long-term
Organise innovation challenges for students.	Starting now
UTICA and the professional associations should promote the creation of discussions on the technological needs and of their members and invite the R&I system to respond to these needs.	Mid-term

1 INTRODUCTION

1.1 Scope and method

The Horizon 2020 Policy Support Facility (PSF) is an instrument aimed at supporting Member States and countries associated to Horizon 2020 in improving the design, implementation and evaluation of their national research and innovation (R&I) policies and systems. The PSF was set up by the European Commission (EC), Directorate-General for Research and Innovation (DG RTD), under Horizon 2020. Specific support services provide tailored advice, expertise and good practice to help Member States and Associated Countries in the design or implementation of a specific reform or topic concerning R&I strategies, programmes or institutions. This is carried out by an international and independent expert panel which formulates concrete and operational recommendations for the national authorities on the reforms necessary to address the specific objectives.

This report has been produced at the request of the Tunisian authorities through the PSF to address two key issues affecting its economy and R&I system:

- The definition of research priorities – Aimed at effectively combining the bottom-up consultation process with top-down priorities, ensuring both the appropriation of strategic focuses by R&I stakeholders, and smart specialisation towards areas of greatest relevance for Tunisia's scientific capacity and economic development. The analysis builds upon the experience gained under the consultation process, leading to an improvement in how research strategic focuses are defined.

- The promotion of private participation in research and development (R&D) – The panel was asked to analyse and formulate recommendations on the governance and instruments needed to better valorise research results by creating stronger public-private cooperation and further stimulate private investment in R&I.

The emphasis is on better integrating the private sector in the Tunisian R&D system, building on the existing science base, as the key objective is to foster stronger R&I performance in the private sector. The analysis evaluates how research financing should be reformed and if specific incentives should be created for the private sector and to foster public-private cooperation.

While the report does not explicitly focus on innovation, it makes several references to firms' innovation as it is intended as the natural outcome of research activities and firms' collaboration with research institutions. In this respect, the authors of this report acknowledge the problems with the definition of innovation and the lack of clarity and consensus on what 'innovation' means, recently identified by the World Bank with special reference to developing countries (Cirera and Maloney, 2017). The World Bank adopts a broad, Schumpeterian view of innovation, according to which "innovation can be defined as the ability to use knowledge to develop and apply new ideas that result in changes in the production and organizational structure of the firm" (Cirera and Maloney, 2017:2). The applications that qualify as innovation are: the

introduction of a new product or modifications to an existing product; the introduction of a new process or technology in an industry; the discovery of a new market; the development of new sources of supply of inputs and raw materials; the changes in industrial organisation.

The PSF panel of independent experts drafted this report on the basis of documents analysed, feedback from Tunisian stakeholders on the panel's preliminary findings, as well as by drawing on discussions with stakeholders and experts and comments received during field visits.

The methodology applied to this study by the independent expert panel was mixed, relying equally on desk research, face-to-face interviews and the descriptive analysis of data. To support the work of the panel, a background report was produced, summarising and synthesising available policy documents and studies. The expert panel made one four-day visit to Tunisia in May 2018 and one three-day visit in September 2018 in order to interview relevant policymakers and stakeholders, to discuss issues concerning the national R&I system and to reflect on potential reforms.

This report is organised as follows: Chapter 1 provides a description of the Tunisian R&I context, summarising the diagnosis carried out in the Background Report to this study and discussing the challenges facing Tunisia in the area of R&D; Chapter 2 discusses the methodology to identify relevant research priorities for the Tunisian research system; Chapter 3 deals with the issue of promoting private engagement in R&I activities; Chapter 4 points out the biggest issues hampering the governance of the R&I system; Chapter 5 summarises the policy recommendations. The Appendices are presented in Chapter 0.

This report presents the views of the expert panel. These are not necessarily the same as those of the EC, which makes its views known through other channels.

1.2 The Tunisian context

Tunisia was the cradle of the Arab spring, which started in December 2010. The years following Tunisia's revolution were marked by strong political instability and security problems. Since the return to democratic rule in 2015, according to the 2018 OECD Economic Survey (OECD, 2018), Tunisia experienced improvements in living standards across all regions. Despite the progress made, the country faces substantial challenges posed by weak job creation, high unemployment and unsustainable public finances.

As most countries of the Maghreb, Tunisia so far has failed to create economic opportunities on a sufficient scale to absorb the growing pool of youth. Social tensions and regional development inequality remain as the main risks in the country. Moreover, the government is facing the challenge of balancing social stability and the need for fiscal consolidation, notably in the civil service, pensions, subsidies, state-owned enterprises, and competition reforms (World Bank, 2017). Despite a high unemployment rate (15.6% of the economically active population in 2016) and regional inequalities, with 92% of industrial companies located around the three major cities of Tunis, Sousse and Sfax, Tunisia's position versus its neighbouring countries in terms of gross domestic

product (GDP) growth has improved in recent years (Dani, 2018). Tunisia's economic model is oriented towards exports and the country has gradually become a solid trade partner of the European Union.

Tunisia has taken some steps to liberalise its economy and has received in the last ten years foreign direct investments (FDI) in sectors such as energy, electronics, pharmaceuticals, agri-food, tourism and telecommunications. The economic structure of the country shows all the characteristics of a 'dual economy', with a modern industrial base composed of 500-600 export-oriented businesses with more than ten employees and a spread of under-capitalised small enterprises targeting the domestic market, most of them with a single person and 80% concentrated in the services sector, particularly in commerce, transport and storage. The local economy specialises in the service sector, which accounts for over 60% of the GDP and employs nearly half of the country's workforce. The service sector includes the booming sectors of information and communication technologies (ICT) and tourism. Agriculture is also a key industry for the Tunisian economy, accounting for over 10% of the GDP and employing over 12% of the workforce. Finally, industry (manufacturing and non-manufacturing) represents over a quarter of the country's GDP and employs one-third of the labour force. The sector's production includes petroleum, mining, textiles, footwear, food and beverages.

Tunisia has a relatively low R&D intensity. According to UNESCO data,[1] its gross domestic expenditure on research and development (GERD) accounted for just 0.60% of GDP in 2016 (down from 0.70% in 2010-2014). Nevertheless, the country still has a higher level of R&D intensity than the average for Northern Africa and the Arab States. Government is the main source of R&D funding in Tunisia, accounting for about 77% of GERD in 2015. The business enterprise sector accounted for 19% and international sources for a further 4%. Insufficient private investment in R&D is one of the long-standing challenges of the Tunisian R&I system (Dani, 2018). The share of GERD financed by industry is higher than the levels observed in other lower middle-income economies, yet it is below the levels observed in other countries in the region. Moreover, according to government representatives and research institutions, the country suffers from very limited collaboration between industry and research institutions. Tunisia has a high researcher density compared to other countries in the region. According to UNESCO data, in 2016 Tunisia had a total of 22,407 full-time equivalent (FTE) researchers, accounting for 5.5 units per 1,000 labour force. This high researcher density is largely explained by a steady flow of students and graduates of higher education (HE) leading to a research title and a good representation of women (nearly 60% of Tunisian researchers are women). However, the overall majority of the FTE researchers in Tunisia (90%) are employed in HE and 6% in the government sector (i.e. in research centres and government labs). Only 4% of the FTE researchers are employed in industry.

The Tunisian scientific research system currently entails: 13 public universities (one of which is virtual) with 205 faculties and 37 doctoral schools; 39 national

[1] http://uis.unesco.org/en/country/tn?theme=science-technology-and-innovation

research centres, including 21 research centres with active units and labs recognised by the National Authority for Evaluation of Research Activities; 329 research laboratories and 301 research units distributed across the universities and research centres. In addition to universities, academia is enriched by a network of ISETs (*Instituts supérieurs des études technologiques*). The high institutional density is one of the key structural issues in the Tunisian research and HE system. Tunisia has a higher number of HE and scientific research institutions per inhabitant (1.2 per million people, with an estimated number of 11 million inhabitants) than many research-intensive countries and the average in the EU. Together with the public research centres, three other main actors can be identified in the Tunisian research and innovation system, namely: technical centres (*centres techniques*), funded and coordinated by the Ministry of Industry (MoI); innovation spaces, including clusters and technopoles; and intermediaries (i.e. incubators and TTOs). More details are in Appendix B.

R&I policy in Tunisia is developed, funded and implemented at the national level. The Ministry of Development and International Cooperation (MDIC) coordinates Tunisia's Five-Year Development Plan. This plan defines the strategic orientation of all public policies that have an impact on the economic and social development of the country, including R&I. The Ministry of Higher Education and Scientific Research (MHESR), supported by the National Agency for the Promotion of Scientific Research (ANPR), is in charge of the Higher Education sector and scientific research. The MHESR also focuses on the interaction between industry and science and the intersectoral mobility of researchers. The MoI's research mission is to develop and implement government policy in support of the national industrial sector and industry-related services. Sectoral ministries also run R&I promotion activities and programmes in certain fields such as health, agriculture, ICT, environment and energy. In particular, the Ministry of Technology and Digital Economy promotes the digital economy and – but not exclusively – entrepreneurship.

In recent years, the political debate has focused on the need for more concerted activities and a more inclusive decision-making process to shape the Tunisian R&I system and foster R&I performance.

2 DEFINING AND IMPLEMENTING RESEARCH PRIORITIES

Tunisia has been willing to invest considerable resources in R&D in an attempt to become a knowledge economy, recording relatively high levels of R&D intensity.[2] In a context of limited resources and significant socio-economic challenges, the Tunisian authorities aim to maintain this course, extending the benefits deriving from R&D investments to the whole economy and society. Therefore, according to local stakeholders,[3] when in 2016 and 2017 the MHESR engaged in the definition of research priorities, it aimed not only to set scientific priorities, but also to improve the alignment of publicly funded research with socio-economic needs. The process was intended to be participative, inclusive and evolutionary. An important objective was to set up a participatory platform in view of the implementation of the priorities.

Any research budget is based on implicit or explicit priorities and several countries worldwide have worked, like Tunisia, on making these priorities more explicit and more directly linked to societal needs. For example, Morocco and Qatar have engaged in priority setting with a similar focus. Research priorities may also play a key role in longer-term development plans, as can be seen in South Korea and China (Gassler et al., 2004; National Research Council, 2010).

Especially with respect to health research, priority-setting models have focused on the alignment between scientific research and societal needs, with the support of international organisations such as the World Bank or the World Health Organisation (Rudan, 2016; WHO, 2017). In the EU different mission-oriented models and funds, focusing on key technologies or implementing smart specialisation approaches, have been developed. A range of empirical case studies and meta-studies analyse, compare and evaluate prioritisation exercises in various contexts. Key success factors highlighted in these studies are the representativeness of, and procedures for, stakeholder involvement, the evidence base, the analytical approach as well as criteria applied for prioritisation, the level and specificity of the analysis and output, and implementation strategies (Abelson et al., 2003; McGregor et al., 2014; de Haan et al., 2015; Rudan, 2016).

This chapter begins with an analysis of the priority-setting exercise in Tunisia, based on international practice and the relevant literature[4]. Various tools and mechanisms that could support the further development of the priority-setting process and the specification of the research priorities are discussed. The second part of the chapter turns to the implementation of research priorities. It proposes improvements to consolidate funds available for priority areas, to better incentivise stakeholders to contribute to the priorities and to increase the steering capacities of the MHESR.

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[2] The R&D intensity exceeds the average values for Northern Africa and the Arab States (UNESCO, 2015) and the public share of R&D funds exceeds those of Morocco or Qatar (WIPO, 2018). The limitations with respect to data quality mentioned in Section 3.2 apply here as well.

[3] Interviews with Zghal (14.5.2018) and Mezghanni (14.5.2018).

[4] A detailed description of the priority-setting exercise is provided in Appendix C to this report.

2.1 Methods for research priority setting in Tunisia

In this section, we analyse the Tunisian priority-setting exercise based on international comparisons with other countries pursuing similar objectives and key success factors for priority setting identified in the literature (Abelson et al., 2003; McGregor et al. 2014; de Haan et al., 2015; Rudan, 2016).

2.1.1 Involvement of stakeholders

The inclusiveness of stakeholders is a particular strength of the process put into place by the Tunisian authorities.

The priority-setting process started with a nation-wide online consultation open to Tunisian stakeholders, which took place in autumn 2016. The main part of the survey asked participants to take positions on six research areas defined by MHESR. Participants were also given the opportunity to suggest additional themes, but only a small proportion of them did so. The results from the online consultation, and the criteria discussed above, then served as a basis for workshops in each of the six thematic areas, which took place in December 2016. In a next step, three regional workshops were organised in 2017 in Sousse, Gabes and Tunis.

In its report on research priorities, the MHESR highlights that around 2,000 stakeholders were involved in some way in the priority-setting process. The stakeholders included researchers, administrative and technical management, as well as representatives of relevant ministries, economic and social organisations, and civil society (MHESR, 2017). However, the participation in the national online consultation was lower: approximatively 500 stakeholders took part, which corresponds to only 4% of the total number of researchers in laboratories and research units.[5]

The format of an **online consultation** had the advantage of ensuring that participants' input was based on their individual knowledge and not influenced by other participants, making the opinions expressed diverse and independent (Rudan, 2016). Since the online survey was open to all, there was no formal sampling. As it would be very difficult to gather data on the whole population of stakeholders, this was a reasonable approach.

Nevertheless, we advise for future exercises to determine an appropriate mix of stakeholders in advance, and to ensure that invitations to participate in the survey are disseminated accordingly. According to Campbell (2010), particular attention to balance is required when civil society organisations are part of the targeted audience. Special **care is needed to include relevant groups who did not (yet) have strong links to the MHESR** (e.g. young researchers, private companies from various sectors), avoiding issues of selection bias. Furthermore, **participation in the surveys and workshops should be**

[5] Data provided by MHESR: Table 'Researcher institutions by discipline'; since the 500 stakeholders also included private companies and representatives from public institutions, the effective percentage is yet lower.

monitored to ensure that all relevant stakeholder groups are represented throughout all stages of the process and in order to control for biases.

After the online consultation, stakeholders were involved in thematic and regional **workshops**. Since we do not have information on the participants in the workshops, we cannot comment on the representativeness of stakeholder involvement in the further stages of the priority-setting process. However, we can say that the workshop format was widespread in prioritisation processes in line with statements by McGregor et al. (2014), and well adapted to the objective of setting up a participatory platform. It provided a forum for interactions between researchers of different institutions, policymakers and users, which in Tunisia otherwise depends largely on personal initiatives.[6]

Based on the experiences gathered during the priority-setting process, it is the current authors' view that **more lasting structures for stakeholder involvement should be developed. Regular exchanges between policymakers, researchers and users support the implementation of priorities within research institutions and the translation of research into practice.**

The broad network set up by the *Unité de Gestion chargée du Programme Européen Recherche & Innovation Horizon 2020* (UGPE-H2020) to support Tunisia's participation in Horizon 2020 is a valuable step in this direction. Such efforts should be increased to stimulate more lasting dialogue between policy and research processes, so that they may influence each other (Campbell, 2010). It can also bring people together around research questions and spur alliances, as intended in the recent priority-setting exercise in the Netherlands. Formal platforms fostering networks oriented towards the priorities should be established.

The development of informal exchange fora should also be supported. Box 1 describes the functioning of such platforms in France. Another example from South Africa shows the potential added value of informal policy fora (

). In Tunisia, we learnt of the development of a similar informal network called Pharma-in, which brings together actors from research institutes, universities and a technopole, including private companies. The objective is to identify common interests and potential for cooperation.[7] Such fora could include a mix of in-person and electronic exchange (e.g. set up a social network, organise a conference). **Informal fora can help to foster partnerships between enterprises, public entities and research and knowledge institutions,** which Tunisia is working towards in the context of its smart specialisation strategy (ANPR, 2018; Morgan, 2017). Projects on priority topics that could qualify for the

[6] Interviews at IRESA, SUCOM.

[7] Interviews at UTICA, 21 September 2018.

ANPR's funding instrument for so-called 'federative' research projects (*Projets de recherché fédérés*, PRF)[8] could also emerge from the fora.

Box 1: Platforms to structure coordination and collaboration between research institutions in France

The creation of national research platforms contributes to the improvement of structured national coordination between research institutions, research centres, universities, HE schools and research-intensive companies. In France, five such informal platforms (called *alliances de recherche*) have been created in 2009, in the following areas:

- health sciences (Aviesan)
- energy sciences (Ancre)
- IT sciences (Allistène)
- environmental sciences (AllEnvi)
- humanities and social sciences (Athena)

These fields have been chosen to correspond to the societal challenges identified by the national R&I strategy of that time. Athena is more disciplinary, and therefore transverse with the other platforms. Those platforms do not cover all research fields, as for instance mathematics and astrophysics are not included. The CNRS, a key public research organisation in France, which conducts and funds research and plays an important role in science policy, can be seen as a kind of "all fundamental research" platform. The university rectors' conference (CPU) and the CNRS are members of all platforms.

These platforms are simple structures, with no regulatory definition, no legal entity, and no direct budget from the ministry. They round up all public research institutions working in that field by signing a contract defining their own governance, which differ from one another. All human resources and funding are provided to these platforms by members.

The first step of the National Research Strategy definition was to ask for proposals covering the main societal challenges to be discussed later by expert groups and the inter-ministerial committee. Each year, these platforms offer advice about research priorities in the framework of the National Research Strategy, which is the basis for drafting the annual programme of the national research projects funding agency (ANR). Their chairs sit in the inter-ministerial committee (*COMOP Recherche*) which coordinates the National Research Strategy with institutional research strategies.

[8] As noted in the Dani (2018), in Tunisia national project funding is allocated through calls for proposals of the PRF. The budget for the PRF is generally very low. In the period 2002-2014, only 22 projects were funded by the PRF for a total amount of 10,788 thousand TND (Hassan, 2015).

They identify research potential and strengths to face new societal challenges (radicalisation and security…).

They define their own priorities and methods for collaboration. They discuss and coordinate the scientific strategies of their members, considering knowledge limits, the coherence of the projects, the means and capacities. They coordinate new research infrastructure projects and help to define the national roadmap for research infrastructures. They promote interdisciplinarity in their field. They match skills and resources to bid for projects funded by national or European programmes. They write and publish foresight studies and organise conferences in their field. They coordinate member activities at European and international level (GIEC, COP, universal exposition, UN-SDG…). They represent France in the governance of dedicated intergovernmental initiatives (JPI, ERANET, EJP…). They harmonise and simplify administrative processes for collaboration among their labs. They structure and promote the results of research in their field and promote collaboration with companies. They are State interlocutors (ministries, Parliament, *cour des comptes*, audit inspections…) for the definition and implementation of thematic policies.

Source: Expert panel analysis

Box 2: The Arid Zone Ecology Forum in South Africa

In a study on research agendas and priorities in South Africa, Mouton et al. (2006) describe the Arid Zone Ecology Forum, an informal network, which "brings together at annual conferences, researchers, conservationists, postgraduate students, farmers and other interested groups who are concerned with addressing and finding solutions to problems in the arid regions of southern Africa". Participants interviewed by Mouton emphasise the importance of the network's informal atmosphere, which is enhanced by the delocalised setting of meetings in small towns, enabling participants to engage with 'on site' research projects. The interviews suggest that the network stimulates participants to "reflect on practical implications of the implementation of (…) [research] ideas" and that "the research interests of the diverse members arise 'naturally'" from the interactions between knowledge producers and users at grassroots level. Mouton sees this as an important complement and reinforcement of more formal mechanisms, which strengthens "the absorptive capacity of informal research organisations and (…) indirectly develop much needed capacity of civil society to act as a knowledge brokers for their respective constituencies".

Source: Mouton et al (2006)

2.1.2 Evidence base

In the context of the academic literature, the approach taken by the Tunisian authorities can be considered interpretative, i.e. focused on "creating consensus among stakeholders", as opposed to technical, data driven-approaches (Campbell, 2010). This seems appropriate as the definition of priorities, especially across issue areas, inevitably involves value-judgements (Rudan et al., 2008; WHO, 2017). Nevertheless, interpretative approaches can and should build on **high-quality** and, where appropriate, **quantitative information**.

Systematic analyses of research capabilities (e.g. regular and detailed bibliometric analyses) and the needs of industry and society (eventually based on existing reports) would have been useful to provide a more systematic evidence base for the priority setting.

The website created for the online survey provided participants with a range of background information, including a recent strategy document of the MHESR and the very comprehensive PASRI Report on the Tunisian Research and Innovation System. Giving participants in the survey the opportunity to suggest additional information bases helped to ensure that no relevant information was omitted during later stages of the process. However, the documents provided were rather lengthy and diverse. A systematic approach is also a **necessary condition** for an **effective smart specialisation strategy** (Kleibrink et al., 2017; see also Section 2.1.4).

The results from the stakeholder consultation provided a useful basis for the thematic and regional workshops, however information is lacking on the ways in which this material was used, and whether any additional evidence was used.

An explanation of the objectives pursued by the MHESR, the criteria for the identification of priorities and the role played by the online consultation would have helped to reduce this 'diversity' in the level and detail of the answers and facilitate the interpretation of the results. However, the website lacked a contextualisation of the online consultation and the priority-setting exercise. In addition, while the survey was online, the MHESR organised a workshop with specialists on the six themes to discuss the methodology for the subsequent process and the criteria to evaluate the priorities (i.e. importance of the current or potential added value; importance of alignment with national strategies and commitments; feasibility or availability of resources and capacity; and level of urgency). The methodology workshop therefore took place in parallel with the online survey. **Discussing the methods earlier in the process would have helped to further focus the stakeholder consultation.**

2.1.3 Analytical approach and criteria used for prioritisation

The priority-setting process aimed at focusing research efforts towards socio-economic needs. However, it resulted in a list of topics of societal relevance rather than research priorities (for example "sustainable management of water resources"). On very few occasions, the priorities were phrased in terms of technologies ("nanotechnologies and intelligent materials"); in those cases, there was no reference to corresponding needs.

Table 2 shows the different steps in the priority-setting process with their respective focus and output. 1) The starting point for the Tunisian prioritisation process were six research areas identified by the MHESR (e.g. water, energy, food and agriculture; medicine and health sciences; humanities and social sciences; environment and natural resources). 2) The online consultation focused on the definition of sub-topics (e.g. water treatment, solar energy, desalination). 3) After the regional workshops and a second round of prioritisation, six "national priorities in terms of scientific research" (MHESR, 2017) or "national priority challenges" (*défis prioritaires nationaux*) were communicated in summer 2017.

Table 2: Inputs and outputs of the priority-setting process

Step of the priority-setting process	Level of analysis	Example
1) Starting point for the online consultation	Research area	Social sciences and humanities, environment and natural resources
2) Inputs collected during the online consultation	Sub-topics	Water treatment, solar energy, desalination, anti-terrorism
3) Output of the priority-setting process	Topics/challenges of societal relevance; Key technologies	Topics of societal relevance: sustainable management of water resources; local governance and participatory democracy Key technologies: nanotechnologies and intelligent materials

In international best practice, prioritisation exercises start with a thorough and structured analysis of challenges and problems. The challenges typically reflect political and strategic priorities and are the basis for the priority-setting process. On this basis, specific problems can be discussed.

Such a **problem-oriented method** was proposed for the definition of national research priorities in Australia and applied also to the definition of priorities for agricultural research in Tunisia by the Institution of Agricultural Research and Higher Education (IRESA) (Box 3 and Box 4). The anticipated output of the priority-setting process were research themes or programmes of high priority to address these challenges and problems.

Box 3: Model for the definition of research priorities proposed in Australia

Source: Office of the Chief Scientist (2012)

Box 4**:** IRESA priority setting for agricultural research

IRESA opted for a problem-oriented approach, inspired by the triple helix model and impact pathways.

The whole process built on challenges identified by the Ministry of Agriculture. On this basis, potential users (e.g. farmer and fishermen syndicates, technicians in public forestry agencies), researchers and government representatives were invited to identify and describe specific problems.

The process was set up to ensure independent and balanced inputs from both groups, so that priorities were imposed neither by the researchers nor on the researchers. The regional perspective was brought in through specific workshops.

In a next step, researchers (*chefs de structures*) analysed the problems based on existing competences and structures, asking how different research disciplines can contribute to the problems in order to identify relevant research themes.

Last, a log frame approach was used to derive research programmes. The objective was to make optimal use of existing structures, to focus on complementarities and to bring together competencies to establish critical mass.

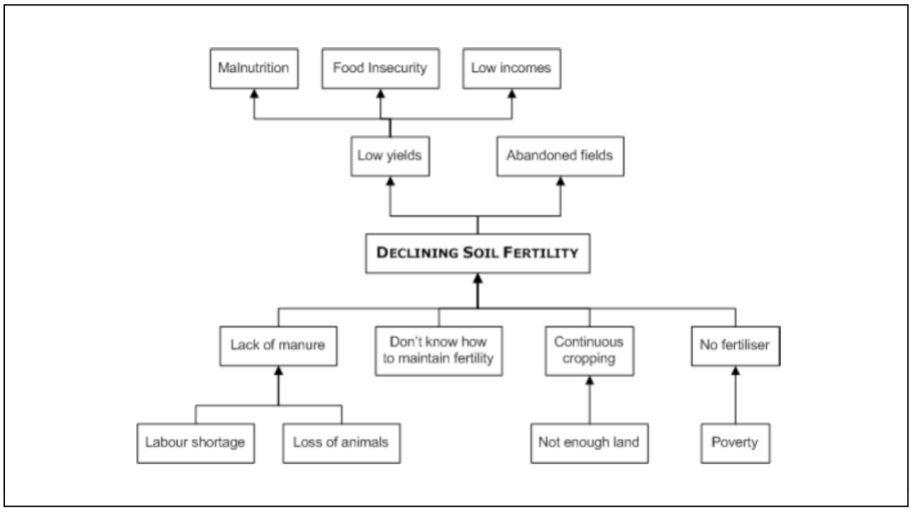
Source: Expert panel interview to IRESA (2018)

A **useful tool** to support the identification and analysis of problems are so called **'problem trees'.** An example taken from Technopolis (2011) is shown in Figure 1. Problem trees help to reflect on the links and hierarchies between interconnected issues. This can help to identify the most important problems to target, to focus the discussion on the potential contributions of research, and to specify the priorities.

In a next step, problem trees form the basis for '**logic models'**, specifying research activities, outputs, outcomes and impacts of research efforts to address the problems identified (the so-called 'log-frame analysis').

A business case study by the ESCWA Technology Centre (Khanfir, 2015) described in Box 5 provides a good illustration of the possible application of **value chain analysis** to identify opportunities for technology transfer and to integrate know-how from various fields of research.

Figure 1: An example of a problem tree



Source: Technopolis (2011)

Box 5**:** ESCWA Case study on the identification of technology transfer opportunities in the Tunisian olive sector

The case study by the ESCWA Technology Centre (Khanfir, 2015) highlights the important contribution of the olive sector to employment and exports, as well as regional balance. Tunisia enjoys competitive advantages with respect to know-how and infrastructure, capacity, variety and processing capacity. However, the olive sector in Tunisia is highly dependent on climatic factors and suffers from bottlenecks in the supply chain and high logistic costs because of the small size of farms. Product design, distribution and international marketing are also not very developed. Khanfir (2015) highlights that the activities with large added value are in production and marketing. He concludes that "the development of new competitive advantage is therefore linked to the acquisition of new skills and competences" in the management of trademarks and AOC, the development of new applications, and the management of the whole supply chain. This "requires R&D in areas such as biotechnology, genomics, environment, energy, IT".

Source: Khanfir (2015)

Once problems have been identified and analysed, the ways in which research may contribute to address those problems must be considered. This requires a detailed and up-to-date evidence base about research activities and competences, which should for example include information about active researchers and their areas of expertise, as well as recent bibliometric data.

The potential scientific contribution to problems should also be reflected in the criteria applied to assess the relevance of different priorities. In the Tunisian case, the criteria clearly reflected the underlying socio-economic objectives pursued. The criteria applied, i.e. added value or relevance, alignment with political priorities, feasibility and urgency, correspond to best practice criteria applied in other priority-setting exercises (Campbell, 2010, McGregor et al., 2014; de Haan et al., 2015; Rudan, 2016). Research capacities were considered as part of the feasibility criterion, with a focus on human resources and the potential for synergies between disciplines.

The literature provides some examples of criteria to analyse the potential scientific contribution with even greater detail. For example, by looking at the potential of research to produce results, which can be translated into practice and are deliverable and sustainable in the Tunisian context (WHO, 2017; Rudan, 2016), or by considering the opportunities to gain access to additional know-how, infrastructure or manpower through collaborations with partners (de Haan et al., 2015).

Explicit steps and criteria to analyse problems with respect to research capacities and to assess the potential contributions from research would ensure that research priorities build on existing strengths and can be implemented effectively.[9]

Based on existing analyses and the interviews conducted during the country visit, overlaps seem to exist between the six priority areas and existing research strengths, for example in health sciences and biotechnology or in fields relating to water and energy (Picard-Aitken et al., 2015). However, the description of the priorities (MHESR, 2017) is very broad and does not include any references to research capacities or potential scientific contributions to the topics identified. An effort in this direction would also help to better focus priorities (see also Section 2.1.4).

Gaps between important research needs and research capacities can be targeted by specific policies, such as knowledge intensive FDI, attracting foreign researchers, or priority areas for new research labs, groups or laboratories, as well as international cooperation.

The Directorate General for H2020 within the MHESR already tries to identify overlaps between European research funding opportunities, national research

[9] Empirical evidence confirms that limited research capacity reduces the ability to implement research priorities (McGregor et al., 2014).

strengths and the national research priorities. In the context of BlueMED, the UGPE-H2020 conducted a national consultation, which aimed to identify synergies between research priorities in Tunisia and those of other participating countries (MHESR, *2018 Consultation – priorités nationales BlueMed*). According to the information provided by the Ministry, the private sector was strongly involved in the consultation procedure. The UGPE also puts particular emphasis on integrating the Tunisian diaspora into the broad network it has created to support the country's participation in Horizon 2020. Tunisia is represented in three-quarters of projects supported by PRIMA, the *partenariat de recherche et d'innovation en Méditerranée*, which supports projects on water provision and sustainable agriculture. A consortium coordinated by Tunisia was also submitted to Horizon 2020 under the heading "inclusive societies" and there are plans to initiate a Tunisian climate hub.[10]

2.1.4 The specificity of the priorities

Identifying the right level of specificity and focus for the priorities is not an easy task. McGregor et al. (2014) stress that "one of the critical aspects of priority setting is achieving the right level of detail in the research priorities, too broad and they fail to provide guidance, too detailed and they risk of being too prescriptive".

The current priorities as published by the MHESR (2017) cover **the whole spectrum of imaginable socio-economic needs**. Their description is situated at different levels, ranging from reference to entire industrial sectors, such as drug design or nanotechnologies, to more specific needs including "the adaptation of technologies to the requirements of small farms" or "intelligent irrigation". With such a **wide spread and high level of generality**, the priorities are unlikely to create focal points for researchers, to be an anchor for cooperation and to create critical mass around specific priority topics. They are also not suited to support differentiation with respect to neighbouring countries, which follow similar priorities, derived from the UN's Sustainable Development Goals (SDGs). Several interview partners also suggested that it would be useful to specify the priorities further.

The optimal specificity of research priorities also depends on the setting. National research priorities will be broader than sectoral priorities and are likely to require **cooperation among ministries**, as is the case in South Korea (Box 7). An exchange between the MHESR and the Ministry of Health, as well as the Ministry of Agriculture and IRESA on the delimitation between respective priority-setting exercises and to explicitly calibrate the levels of analysis would be useful (see also Section 2.2.1). This would also allow for an exchange of experience with different models and on their strengths and weaknesses in the Tunisian context.

Focusing on areas where important socio-economic requirements meet with existing research strengths, as suggested above, would help to further focus the priorities.

[10] Information provided by the MHESR in April 2019.

The examples from Qatar and South Korea (Box 6 and 7) show that there are different ways to do so: options are to address a broad range of societal challenges, but focus on specific problems, as in Qatar, or to focus on very specific, increasingly high-tech sectors with a potential for short- to medium-term socio-economic impact as in South Korea.

Box 6: Research priority setting in Qatar

In 2012, the Qatari government carried out a research priority-setting exercise, involving research leadership, researchers and other stakeholders, to develop a Qatar National Research Strategy (QNRS). Of particular interest is how the initial strategy published in 2012 was relatively general in scope, covering a broad range of research sectors and sub-sectors, while the focus in subsequent versions published in 2013 and 2014 narrowed substantially.

In its initial 2012 version, the QNRS identified five major pillars (Enterprise-Wide Pillar; Energy and Environment Pillar; Computer Sciences and Information Technology Pillar; Health Pillar; and Social Sciences, Arts and Humanities Pillar). Within each pillar were a number of goals: in the Energy and Environment Pillar, for example, seven goals and 16 sub-goals were identified; within the Health Pillar, there were two goals ("Addressing national health priorities" and "Building enabling health research platforms") with 21 sub-goals covering major health-related concerns.

In the 2013 version, the pillars were reduced to four and the concept of "Cross-cutting Research Grand Challenges" was added, identifying 12 challenges facing Qatari society, from Desalination/ Waste water reuse, to Sustainable Urbanisation and the broad category Environment & Society. Within each challenge, the language was often aspirational, and the content clearly included inputs from a diverse range of stakeholders.

In 2014, the number of challenges was reduced from 12 to four by the Qatar Foundation, a government-supported non-profit organisation responsible for implementing the QNRS, which were subsequently the subject of four days of stakeholder workshops. The four challenges identified were: Develop, Refine, and Adopt Enhanced Desalination/Waste Water Re-Use Capabilities (Water Security); Develop/Deploy Solar Energy on the Grid (Energy Security); Develop security technology to protect the critical cyber infrastructure (Cyber Security); Develop plans to tackle Cancer, Diabetes & develop personalized medicine (Healthcare).

A relevant Qatar Research Institute was selected to serve as a "champion" for coordinating research on each challenge across the stakeholder community.

Sources: Qatar Foundation, Qatar National Research Strategy (2012, 2013, 2014).

Box 7: Research priority setting in South Korea

From the 1960s to at least the early 1990s, South Korean economic growth was driven primarily by imitation of technologies developed elsewhere. Research at government-funded research institutes in the 1960s and 1970s was likewise directed towards imitation of and catch-up with foreign technology.

Since the 1980s, however, there has been an increasing focus by the government on innovation, with high importance placed on the promotion of basic research and the development of core technologies for innovation-based economic growth. Total spending on research has risen substantially, with GERD increasing from 0.38% of GDP in 1970 to 4.3% of GDP in 2014. Government investment as a percentage of total R&D investment fell substantially over the same period, from 71% in 1970 to less than 25% in 2014.

Today, basic research in South Korea is generally funded without being limited to specific priorities. Alongside this core funding, additional funding is directed to selected priority sectors, chosen in line with the overall goal of transforming an imitation and catch-up oriented economy into one that is primarily innovation-oriented. There is a strong focus on funding sectors that will directly stimulate economic growth in the short to medium term, as set out in 1999 in the 25 year "Vision 2025". Within this overall framework, there have been various shorter multi-year plans, as well as the two major priority-based funding programmes: The Global Frontier Project and the Next Generation Growth Engine Programme.

The Global Frontier Project funds basic and applied research to develop core technologies in selected areas (initially: ICT, Biotechnology, Life Sciences, Nanotechnology, Environmental Technology, and New Materials).

The Next Generation Growth Engine Programme focusses on Technology and Innovation, with 10 growth engines selected through inter-ministerial cooperation, and 80 key technologies selected to support them. The 10 growth areas are uncommonly specific compared with most other countries and were selected based both on the importance of global market and the possibility of local competitiveness. The initial 10 were: Digital TV/Broadcasting, Digital Displays, Intelligent Robots, Future Automobiles, Next Generation Semiconductors, Next Generation Mobile Telecommunications, Intelligent Home Networking, Digital Content and Software Solutions, Next-generation Batteries and New Bio-medicine Organs.

Overall, Korean research priority setting is highly top-down in comparison with most other countries, with funding priorities determined by the National Science and Technology Council together with various ministries, in particular the Ministry of Science and Technology, and has historically been carried out to a large degree by government-financed research institutes.

Sources: EC (2017); Gassler et al. (2004); Koo, H.-C. (2003).

The Qatari and Chinese examples also emphasise bringing together researchers from **different scientific disciplines to address societal challenges**. In Qatar, a specific government funded research institute was selected as a "champion" to stimulate interdisciplinary cooperation, while in China very large sums were invested in multidisciplinary "mega-projects". In both cases, this allows for a focus on specific societal problems, while allowing for contributions from various scientific disciplines. The specificity of the priorities tends to increase as prioritisation exercises are repeated (de Haan et al., 2015), as appears from the cases of Qatar and China (Box 6 and Box 8). In both cases, however, this also involved **top-down reduction in the spectrum of priorities** by government officials.

Box 8: Research priority setting in China

Few countries have seen as large an increase in R&D spending – both in relative in absolute terms – over the last two decades as China. Between 1996 and 2015, GERD rose from 0.56% to 2.07% of GDP.

Alongside funding for basic research, the Chinese approach is characterized by large-scale funding to drive research in specific areas of technological innovation as well as funding for specific industries that promote social development. In addition, various "mega-projects" have been funded with the aim of achieving significant technical breakthroughs in areas related to national socio-economic development.

Research priority setting in China takes place largely within the context of Mid and Long-Term Plans for Science and Technology (MLPs), of which eight have been formulated since 1956. Over time, the key goals of the MLP have evolved from a narrow focus on atomic energy, weapons technology and semiconductors in 1956 to a much broader range of priorities today.

In the initial phase of preparing the current MLP, 20 key science and technology issues were identified by a group of government officials under the leadership of the Prime Minister, assisted by an expert group. In a second phase, consultations were carried out on these issues in numerous workshops among a broad group of over 2,000 scientists, policy experts and business executives, as well as government and university representatives. The MLP was subsequently drafted by government officials on the basis of these consultations, along with complementary policy measures for its implementation. Since too many priorities were proposed in the consultation phase, the final priorities were selected in accordance with principles established at high-level meetings, presumably by government officials. Altogether, 11 priority fields were identified, along with a total of 68 priority themes within the 11 fields.

In his analysis of the process, Li (2009) describes it as scientific, including input from many experts; efficient; democratic, with participation by many stakeholder groups including the general public; as well as both open (in the consultative phase) and secretive (in the drafting phase).

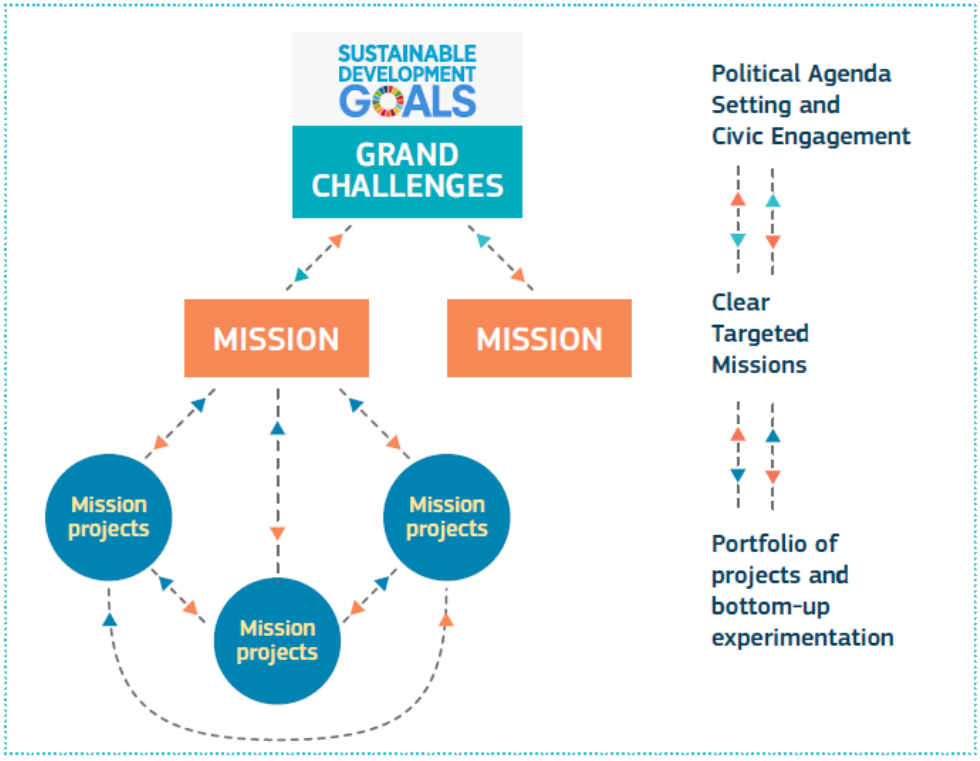
Links: http://www.most.gov.cn/eng/programmes1/200610/t20061009_36225.htm

Sources: Li (2009); National Research Council (2010).

The mission-oriented research proposed for the next Framework programme "Horizon Europe" is similarly problem-focused. Missions translate broad challenges into "concrete, measurable, and, most importantly, achievable missions" (Mazzucato, 2018) (Figure 2). With the missions, the EU intends to focus resources on solving important problems, while allowing for spillovers to other sectors. The aim is to rally a wide range of actors, disciplines and types of research around specific issues (Mazzucato, 2018). A similar principle could be applied in Tunisia on a smaller scale. Building on the value chain analysis describe above (Khanfir, 2015), for instance the objective could be to increase value added in the olive sector.

A possibility would be to define priorities in two dimensions: (1) socio-economic needs, and **(2) key enabling technologies.** This would be aligned with the EU approach illustrated by the Horizon 2020 structure and the Pillars for "Industrial Leadership" and "Societal challenges". **In any case, synergies between fields or different actors should be particularly supported.**

Figure 2: From challenges to missions



Source: Mazzucato (2017)

Another tool to set more specific priorities is smart specialisation. Smart specialisation strategies focus not on whole sectors or technologies, but on detailed areas of activity with strong potential for economic transformation and growth. The idea is to exploit competitive advantage and increase differentiation. The potential of new domains is assessed based on the current economic fabric, and with strong and broad stakeholder involvement (Kleibrink et al., 2017).

Smart specialisation is a comprehensive tool, which brings together many of the concepts described above. It is data-driven and requires detailed and reliable data about economic and innovation activities (see Chapter 5). Kleibrink et al. (2017) highlight that "governments need to first understand where their economies stand and how they arrived at their current economic fabric". According to the authors, "A better knowledge of the socio-economic fabric is an important precondition for identifying key domains on which to focus effort" (Kleibrink et al., 2017).

Smart specialisation also requires close cooperation between different actors – private companies, knowledge society, government actors, civil society – to identify opportunities (Kleibrink et al., 2017). This highlights the importance of structures for stakeholder involvement (see Section 2.1.1). Morgan emphasises that "the capacity of entrepreneurial firms within regions to establish the network capital required to innovate in an increasingly open environment" is "a key determinant of regional innovation and growth differentials". However, he suggests that where mutual trust cannot be presupposed, the first step should be to build mutual understanding rather than to expect immediate cooperation. He suggests seeing "the establishment of suitable triple-helix innovation platforms (including national and regional authorities) as an intermediary step, a vehicle to kick off an entrepreneurial discovery process, before defining "smart specialisation domains" (Morgan, 2017). Such an intermediary step could also be useful in the Tunisian context.

Such an approach also opens the focus beyond the economic perspective at the core of smart specialisation. Morgan stresses that the role of users and citizens should be formalised, and social enterprises given greater attention in smart specialisation approaches. In this context, education is important, to increase the general level of human capital, or to focus skill development on narrower fields, in line with the vertical approach of smart specialisation, which focuses on detailed areas of activity (Morgan, 2017).

Also, with smart specialisation priorities evolve and become more specific over time. As Kleibrink et al. (2017) point out "progressive and interactive efforts are needed to accumulate experience and trigger policy learning" (Kleibrink et al., 2017). They propose a **"trajectory for smart specialisation" for transition countries, which could be valuable in the Tunisian context** and is described in Box 9. The underlying idea is to "take the 'experimental approach' from smart specialisation" and apply it to the smart specialisation strategy itself. This echoes the ideas about lean innovation processes illustrated in Box 18.

Box 9: Trajectory for smart specialisation in transition countries

Since smart specialisation depends on a strong evidence base and adequate governance, Kleibrink et al. (2017) propose a "trajectory for smart specialisation" for transition countries. This includes the following four steps:

1) "Build a 'competence centre' to manage the process of learning and strategy making" and to "provide a comprehensive analysis of your economic fabric";

2) "Begin with a pilot on a well-developed economic domain with willing and capable stakeholders to experiment with different approaches for defining the fine-grained sub-areas of prioritised domains and designing ways to mobilise the right stakeholders (domain experimentation)";

3) "Take the 'experimental approach' from smart specialisation and apply it in one capable and willing region. This would help apply the approach to other regions, enabling a cumulative process over time to overcome the lack of data about the situation on the ground (territorial experimentation)";

4) "Sequence your process in a way you can harvest the low-hanging fruit in the short-term (non-R&D measures), focus on the core of your activities with high potential in the medium-term, and leave R&D-heavy breakthrough programmes for the longer term".

Source: Kleibrink et al. (2017)

2.1.5 Research fields with no immediate connection to the priorities

In the Tunisian research landscape, there are pockets of excellence with no obvious connection to the priorities. A bibliometric analysis conducted in the context of the PASRI report (Hassan, 2015; Picard-Aitken et al., 2015), for example, highlighted the good performance of computational mathematics and mathematical physics, sports medicine or anthropology. These areas do not just contribute to the dynamism and visibility of Tunisian research but also indirectly benefit the priority areas.

Research fields without obvious connection to the priorities today may contribute to the solution of tomorrow's problems. Since research capacities take time to develop, it is advisable to the consider the **price of a reallocation of resources** to research fields with direct relevance for today's priorities may have for more basic research fields that are currently strong. **There should be incentives for all researchers to consider potential contributions to priority challenges, even long-term and indirect, and fora for exchange with practitioners and more applied researchers to create awareness for the potential of new lines of research.** At the same time, a sufficient proportion of funds needs to be allocated deliberately **outside the priority areas**, to allow new research avenues, directions, and areas, which may ultimately lead to new national priorities. With reference to Horizon 2020, this would correspond to the "Excellent Science" pillar, which complements "Industrial Leadership" and "Societal Challenges" mentioned above.

2.1.6 Information about the priority-setting process and its outcome

Finally, it is important to document the priority-setting process so that the rationale and the eventual priorities can be clearly and transparently justified. To this effect, a full documentation of the process, as suggested elsewhere, would be useful. This documentation should include information about the rationale behind the different steps in the priority-setting process and the roles of those involved. There should also be justification for each of the priorities eventually selected. Stakeholders that did not participate in the process should be able to understand how and why priorities were selected. It should also be clear what they mean in practice, for example in terms of funding allocation. This will support acceptance and implementation.

2.1.7 Conclusions and recommendations

In the Tunisian context, research priorities seem an appropriate tool to focus limited resources on important socio-economic challenges and, ultimately, to invest public money effectively. We would therefore advise the MHESR to pursue the process it has initiated, to adapt the priorities periodically to changing circumstances, and to refine the process and its results along the way.

Based on existing analyses (OECD, 2018; World Bank, 2017; Hassan, 2015) and the interviews conducted during the country visit, the six priority challenges seem to reflect current challenges in Tunisia and there are overlaps with existing research strengths, for example in health sciences, biotechnology, food sciences or in fields relating to water and energy (Picard-Aitken et al., 2015). The existing priorities therefore constitute a good starting point for a next cycle of priority setting.

In this context, we recommend the following developments to the process and methods:

- **Adopt a problem-oriented approach, considering the potential of research to contribute to specific issues, and specify priorities further**

It is necessary to identify and analyse specific problems or technological needs related to the challenges identified in 2017, drawing on useful tools like problem trees, logic models or value chain analysis. Tunisian authorities should consider the potential contribution of research and build on existing strengths by matching problems to research capabilities and potential. This will support the effective implementation of priorities.

Develop a more systematic evidence-base for the priority-setting process (e.g. regular, detailed bibliometric analysis as suggest in Section 5.1.1), including an analysis of current industry needs and research strengths. This provides the necessary basis for an effective smart specialisation strategy. At the moment, the priorities describe broad topics of societal relevance. It is necessary to specify them further to identify national niches and focus resources on areas where problems meet research potential, to provide a more concrete anchor for potential cooperation and to allow for a clearer positioning of Tunisian research.

Gaps between capacities and crucial needs can be targeted with specific policies, such as attracting knowledge intensive FDI and foreign researchers, or defining priority areas for new research labs, groups or laboratories, as well as international cooperation.

- **Support the development of formal and informal platforms fostering networks oriented towards the challenges**

For formal parts of the process, determine an appropriate mix of stakeholders in advance and monitor participation to ensure representativeness throughout the process. Consider increasing the participation of younger researchers. Consider a workshop specifically for users of research to ensure that both public and private socio-economic needs are captured before being mediated by researchers' perceptions.

Clearly communicate the objectives of the priority setting to stakeholders and clarify their role in the different stages of the process. Allow time for adequate preparation and ensure that stakeholders provide their opinions independently throughout the process and that there is space for an open and reasoned discussion of different viewpoints. It is also important to explain and justify the selected priorities so that even those who did not participate in the process understand how and why these priorities were selected, and what the selection of these priorities means in practice, in terms of funding allocations and other policy measures.

Encourage continuous informal dialogue to coordinate research efforts and identify potential synergies, including from interdisciplinary cooperation. Informal fora can provide a basis for smart specialisation partnerships or result in PRF on priority topics.

- **Consider that a reallocation of resources to areas of socio-economic priority may have a price for more basic research fields that are currently strong, like mathematics or physics**

Include as many researchers as possible in policy platforms to consider possible, even long-term and indirect, contributions to the priorities. **Ensure sufficient funding for excellent researchers and research areas outside national priorities, to secure career prospects, maintain the quality and visibility of research in these areas, and allow new research directions and potential new national priorities to emerge and evolve.**

In practice, **the priority-setting process could include following steps** (Table 3):

Table 3: Steps for priority setting

Steps	Actors	Useful tools
Identification of broad challenges	Government, MHESR	National priorities defined in 2017 provide a good starting point
Identification and analysis of specific problems	Broad range of stakeholders, a few researchers	Stakeholder fora Problem trees
Analysis of potential research contribution	Researchers, stakeholders	Solid evidence base (e.g. bibliometric data) Value chain analysis Logic model
Prioritisation of research topics	MHESR, in consultation with stakeholders	Clear roles and responsibilities Transparent communication and justification of results
Specific policies to incite and support relevant research and target potential gaps	MHESR, ANPR	Smart specialisation approaches See Chapter 4.2

2.2 Implementation of the research priorities

The national consultation on scientific research priorities was launched in November 2016 and concluded in May 2017. This prioritisation process concluded on the definition of six national priorities for research:

- Water, Energy and Food Security;
- Emerging Democratic Society;
- Quality Healthcare;
- Digital and Industrial Transition;
- Governance and Decentralisation;

- Circular Economy.

A National Research Strategy must be evaluated assessing its effects. The value of any tool lies in its use and a strategy is a political tool. Its main value is neither determined by the quality of its writing, the representativeness of its setting process, nor the relevance of its priorities, even if all are necessary. The main value of a strategy lies in its implementation, i.e. in its ability to stimulate dynamics in the human organisations it is addressing to increase their performance.

2.2.1 Public programmes to implement the six research priorities

The National Research Strategy has been set up with representatives of different ministries and is endorsed by the Government. Therefore, all ministries and funding areas are to be considered to implement this strategy.

To date, the MHESR has several instruments to direct funds to the research about priorities:

- The call for the PRF for 2017-2019 was exclusively limited to the six national research priorities (call November 2017). It aimed to support cooperation and synergies between multidisciplinary research teams and socio-economic stake-holders. Each project had to involve at least two research structures (laboratory or research units), with the requirement that at least one should be a laboratory, as well as at least one socio-economic partner from the public or private sector. Projects were evaluated by CNEARS and selected by MHESR.

- The Quality Support Programme (PAQ in French) has two calls dedicated to collaboration between public and private sectors: PAQ-Post PFE/MFE and PAQ-Collabora. This programme ran twice in October 2017 (with a budget of 3,308,647 TND) and in May 2018. The classification of the funded projects by research priority area is presented in Table 4.

- The Early Career Programme (programme jeunes enseignants chercheurs) was set up to incite young researchers (maîtres assistants) to engage with the national research priorities. Relevance with regard to national priorities was a selection criterion, along with the scientific excellence and originality (call November 2017). In 2017, a bonus for researchers active in the priority areas was implemented (interview, 14 May 2018). It is unclear whether the mechanism by which the fit with priorities was considered and communicated to researchers to create involvement.

- A bonus of 10% of the recurrent institutional funding by the MHESR was introduced in 2017 for laboratories and research units focusing on research priorities (interview, 14 May 2018).

Table 4: PAQ funded projects

Research priority	Number of funded projects
Water, Energy and Food Security	12
Emerging Democratic Society	4
Quality Healthcare	5
Digital and Industrial Transition	4
Governance and Decentralisation	0
Circular Economy	2

The PSF country visits showed that **representatives from universities, research institutes and technopoles**[11] **are aware of national research priorities**. The fit between thematic institutions and nation-wide priorities[12] is good, even if achieving this goal was not easy for large and multi-disciplinary universities.[13] But all of them complained about the administrative burden that is necessary to properly implement these priorities and about their lack of skills and resources. Researchers already working on a subject in one priority field believe that the priority-setting strategy represents an opportunity to gain access to funding and properly value their activity. However, other researchers are not concerned and lament the lack of communication and tools to promote participation. Few interviewees were sceptical about the broad focus of the national priorities, expressing more concern about the risk of decreasing funding for scientific research on topics outside the priorities (humanities, mathematics, etc.).

The financial volume associated with the aforementioned measures is low, so it is important to look at the activities of sectoral ministries that address directly or indirectly scientific activities.

Health research is coordinated by the Ministry of Health, which recently published a 5-year health plan (2016-2020) including one axis entitled "Bet on innovation" (*Faire le pari de l'innovation*). The health research is therefore oriented by its ability to create innovation. Five priorities[14] are defined in this strategy:

[11] Institut Pasteur, IRESA, SupCom, Institute for Nanotechnology in Sousse, Researchers participating in meeting at the MHESR, Technopole Sidi Thabet, presidents of university.

[12] Institut Pasteur, IRESA, ESPRIT, SupCom.

[13] Université Al Manar, Université de Carthage.

[14] In French those priorities of the five-year 'Plan Quinquennal 2016-2020 for health' in Tunisia are: *Réduction des inégalités sociales et protection des groupes vulnérables; Réorganisation et rationalisation des services de santé; Renforcement du rôle du patient-citoyen comme acteur du*

- Decrease of social inequalities and safety of vulnerable groups;
- Reorganisation and rationalisation of health services;
- Empowerment of the citizen-patient as a stakeholder in the health system;
- Behavioural and risk factors for youth and teenagers;
- Prevention and risk management and implementation of the international health regulation.

This health research plan had the potential to become the de-facto health priority in the National Research Strategy; however, insufficient political effort was invested into achieving this recognition of its importance. In general, science and technology programming in Tunisia is still driven by temporary or short-term priorities, such as digital health, HIV and sexually transmitted diseases, cancer, tuberculosis, obesity, clinical tests, vaccines, etc.

The Ministry of Health and the MHESR work regularly together. The former pays salaries for researchers specialising on health issues, but the career structure is determined by the rules set by the MHESR. During the first country visit, the representative of the Ministry of Health explained that the national research priorities will lay the basis for labs' funding and will be a key criterion for the funding of new projects. The performance of labs and research units will be assessed on the basis of these priorities. No more detail was given about those programmes, the amount of funding or the evaluation criteria. No evidence of political communication or tools encouraging greater researcher involvement was given.

Research in agriculture is defined by the IRESA, a joint institute of the MHESR and the Ministry of Agriculture. Research in this area is primarily concerned with the first priority of the National Research Strategy (energy, water and food safety), and partially with other priorities (i.e. priorities 4, 5 and 6). The IRESA defined its own "agriculture research strategy" with the support of the MHESR. During the PSF visits, representatives from both ministries agreed that there was no coordination problem in the definition of a common strategy, because everyone attributes the highest level of priority to water and food safety. This thematic strategy should therefore be explained as a detailed application of the first research priority.

The IRESA funds excellence consortia working on these priorities through four-year contracts. The funding is based on the expected impact. No detail was given about this allocation. The Ministry for Agriculture pays salaries for researchers

système de santé; Comportement et facteurs de risque des MNTs en ciblant en priorité les jeunes et adolescents; Prévention et gestion des risques et mise en oeuvre du règlement sanitaire international.

dedicated to this subject, but the career structure is determined by the rules of the Ministry for Research.

No evidence regarding the implementation of the National Research Strategy in other ministries emerged during the country visits.

2.2.2 Comments and prospects on implementation of the priorities

The official communication of the MHESR includes a short description of the priorities and their set-up process but does not include any information about implementation tools, even though some effort has been made in the implementation of the priorities. This shows a lack of a systemic strategic approach. Four actions could help to boost the implementation of the priorities:

- to ensure the sustainability of the strategic process;
- to increase the steering capacities of the MHESR;
- to consolidate funds available for priority areas;
- to better incentivise stakeholders to contribute to the priorities.

These actions are detailed below.

2.2.2.1 Making the strategic process sustainable

To increase the acceptance and the involvement of the research community in the strategic approach, researchers need to know and believe that this approach is a long-term process aimed at improving framework conditions for the Tunisian research system. They should be involved in the future orientation of the system. This implies:

- The introduction of the National Research Strategy and its implementation in the law at the highest possible level;
- The definition of the strategic approach as a cyclical quality process, including the duration, periodicity and yearly publication of a monitoring report;
- The definition of the missions of an inter-ministerial committee to pilot the implementation of the priorities and of the Parliament as responsible of ex-post evaluation of this implementation (the Parliament controlling the policies decided and implemented by the Government is an international common practice);
- The definition of the main tools and programmes contributing to the implementation of the priorities.

Sustainability of the strategic process is key for its efficiency.

2.2.2.2 Steering the national research system

The majority of ministries should be involved in the implementation of the National Research Strategy and its six priorities. Therefore, political and administrative incentives should be launched for the other ministries to contribute to, and focus on, implementation of the research priorities. Coordination of the inter-ministerial issues is of utmost importance in order to increase the efficiency of public effort in implementing those priorities. **The coherence and links between national strategies should be expressed**. **Creating an inter-ministerial committee dedicated to R&I** would be useful **to involve and coordinate the programmes and tools of various ministries, focusing resources on the national research priorities.** This would also optimise the use of public resources. The **research priorities should be considered as a framework for the preparation of the R&I policy projects to push in the future 'Five-year Plan'**.

The organisation and assignments of the MHESR itself are also important for the implementation of priorities. The **simplification of administrative processes**, **externalisation of tasks**, development of **automatic treatment tools**, and, above all, giving **responsibilities to research actors** would allow the **Ministry to focus more on its essential strategic function** (objective-based decision-making, allocating new resources for tools focusing on priorities, monitoring the implementation of priorities, preparing evaluations and adjusting the strategy), and on **steering the national research system in line with the priority framework**.

One of the missions of the MHESR is to help research stakeholders coordinate their activities and collaborate to optimise the implementation of the priorities. The **creation for each priority of a platform dedicated to the research stakeholders**, as described in Chapter 2, would not only be an opportunity to involve them in strategy setting, but also to coordinate their strategies, projects and resources. **Business associations could also organise one network** (on the social networks and with meetings, seminars, etc.) for each priority to discuss research, innovation and opportunities.

The MHESR also strives to give research actors the ability to contribute to the national effort. **The direct management of all researchers and labs by the MHESR is less efficient than steering them through intermediate bodies**. Those bodies already exist but don't have the ability and flexibility to operate fully as research institutions. Universities are still understood as teaching institutions. **The research mission should be reinforced:**

- In the governance of the universities (creation of a permanent committee dedicated to research is an exception in the University El Manar because it covers 22% of the Tunisian labs);
- In their institutional strategy (no systematic mission and indicator about an existing internal research strategy in the contract between the universities and the ministry exists yet);
- In their evaluation;

- In their ability to recruit and manage skills corresponding to their internal research strategy.

2.2.2.3 Consolidating funds

The MHESR uses both institutional (block) funding and competitive funding to steer the research towards the policy priorities. The use of institutional funding (10% bonus) risks decreasing the acceptance of the strategic process. The bonus given to labs working in priority fields implies a reduction of the funding for labs working on other subjects. There would be no problem if the labs had stable, sufficient and recurrent funding and access to external funding resources. In a situation where they suffer from funding shortages, this approach will create internal tensions, though. In addition, research in some non-priority fields could decrease or disappear, which would be a loss to the Tunisian research system, especially if the work is internationally recognised.

The competitive research funds are allocated through **the ANPR, which should be strengthened and refocused** on its specific mission: organising competitive calls for research on behalf of public funders (ministries, regional governments, etc.) which means peer selection, funding decision and management, then follow-up and evaluation of project management. The selection criteria, the calls and communication about the call should stay the responsibility of each funder. Benchmarking and partnership with similar foreign agencies could help in reaching this goal.

Among the activities of the ANPR, the PRF (*Programme de Recherche Fédéré)* clearly is the main programme dedicated to the implementation of the priorities. Researchers working on all priorities can apply to the PRF. Therefore, **each priority included in the PRF should be co-funded by other ministries, public agencies, public companies and federations of companies involved in that priority**. All of these funders should be represented in a **Priority Pilot Committee**, which would allow discussion and coordination between the different funders. This would increase the resources for the research projects dedicated to given priorities, support the framework conditions for collaboration between research actors, and allow better matching between research activities and societal needs.

The PRF covers a wide range of potential expenses related to the activities of researchers expressed in terms of "direct costing". The "full costing" method is not considered (see Estermann and Claeys-Kulik, 2013; European University Association, 2008), ignoring some costs such as indirect costs (or induced costs) of the research activity, depending mostly on institutions. These costs are related to infrastructure and their amortisation, mutualised support services to write and manage projects, intellectual property and legal services, the premises (rent, lease or depreciation of buildings or plants), legal fees, office supplies and equipment, and other general support services (human resources services, cleaning, library, services for publication, communication, IT services, dues and subscriptions, medical, clothing, transport, catering, security and similar items). Therefore, research institutions and technopoles must balance the indirect costs of PRF research projects with other expenses. It follows that in the Tunisian case

a research project is still considered as the project of one or several researchers, and not the project of one or several institutions.

We believe that 'parent' institutions need to be more involved and lead funded projects. This can be achieved through a mechanism called a ***preciput*** (i.e. a small percentage of the funding attributed to the project corresponding with the cost of salaries) **to institutions** with a set of **national guidelines to ensure the allocation of the project budget to the different hierarchical levels of research institutions** (i.e. the lab, the establishment and the university) is transparent and fair.

Moreover, as stressed above, funds for research projects from other ministries should be included in the priority areas. The **Citizen Health** priority and its four goals[15] are wide enough to cover all or most health research subjects. The details of the health scientific research are still determined outside of this strategy by a series of ministerial plans, or through contracts directly with the labs. There is no evidence yet that the strategic approach changed criteria and funding allocation in the health research sector. For the **Agriculture** priority, it should be better communicated that the current sectorial research strategy constitutes the implementation of the first priority. The implementation tools dedicated to this priority should be discussed with other ministries involved. At present, only these two priorities include detailed scientific stakes behind the societal challenges. The inter-ministerial committee proposed in Section 5.1.2 should involve more ministries and resources in the other priorities.

Efforts to obtain resources from European and international R&I programmes should also focus on the research priorities. **Mapping the Tunisian scientific diaspora working on subjects related to the Tunisian research priorities** would be helpful in creating projects and collaborations capitalising on the experience of foreign countries and in focusing Tunisian efforts to participate in Horizon 2020, the future Horizon Europe, and in other international programmes on the priority areas.

2.2.2.4 Incentivising stakeholders

Most of the research institutions and researchers met during the visits underlined that the current process for approval of expenses (i.e. no direct responsibility and subjected to ex-ante ministerial control) drastically reduce their interest in participating in a national, European or international project. These conditions discourage researchers and research institutions from implementing priorities through competitive and collaborative research projects. Some reforms would allow universities and researchers to manage the budget of research projects currently subject to ex-post control by the Ministry:

[15] *3. Santé du citoyen: 3.1 Drug design – développement de vaccins et biosimilaires; 3.2 Gouvernance et économie de la santé; 3.3 Epidémies, maladies chroniques et maladies nouvelles; 3.4 e-santé et télémédecine*

- **The process for universities to have the EPST legal status should be simplified and accelerated. This legal status should allow them greater financial autonomy. This process should apply to all universities;**

- **The universities and technopoles should be authorised to manage their budget in a double accounting method (1. normal accounting to manage the official public budget, with the classical public rules and 2. new accounting rules, based on the private rules giving more freedom for operating expenses dedicated to the management of the research projects funded by national, private or international funding). This double accounting has to be controlled ex-post only.**

Researchers and research institutions are also sensitive to the valorisation of their work, both in public and private sectors. There should be **an inter-ministerial framework and published guidelines and templates to structure 'expertise contracts' between a university** (only, as the employer) **and the public sector** (ministries, agencies, regions, cities…), associations, companies or federations to develop valorisation of the research.

Finally, the PSF visits have shown no evidence of any career incentive to involve researchers and support staff in the implementation of national research priorities. In this respect, various in human resource management initiatives could be undertaken:

- **Focusing doctoral fellowships and academic recruitment on priorities**. The current academic hiring freeze poses a threat to the sustainability of the implementation of research priorities as it can lead to brain drain, when the whole academic system should be refocused around these priorities (i.e. via the recruitment of research-experienced people from the private sector, via the promotion of participative society research, the resolution of scientific legal issues, the reform of the TTO system, the introduction of project-writing and managing support experts, etc.);

- **Changing doctoral fellowships into employment contracts with the university** or its association/spin-off/subsidiary (private rules), because it would:

  - Reinforce the ability of the university to set up and implement its own research strategy in the national framework;

  - Valorise the labs involved in priority research fields, having more formal members/contributors;

  - Professionalise doctoral programmes, changing candidates' relationship with other academic staff and improving their curricula (e.g. after their thesis defence they will be looking for a second employment experience, not for a first one);

  - Present R&I as a professional high-value activity for socio-economic partners;

- **To allow universities to employ young researchers in post-doc positions via short-term contract** with their associations, spin-off or subsidiaries under simplified private rules with the funds from external resources (national, European or international projects, contract with a company or an association or federation of companies, expertise for the public sector, etc.);

- To accelerate careers (and salaries) for researchers directly involved in priority research for more than 50% of their working time;

- **To compensate** for the need of recruiting a temporary teacher (short-term contract, with the university as the employer) **when a teacher is completely or partly released of his or her teaching obligations in order to focus on research projects in the priority fields** or to contribute to project writing and managing support

2.2.3 Conclusions and recommendations

Several measures are necessary in implementing the national research priorities. We recommend Tunisian authorities take the following steps:

- The implementation of the research priorities must be governed at the inter-ministerial level, with the institution of an inter-ministerial committee (see also Section 5.1.2). This committee should involve and coordinate all the ministerial policies in the framework of the national research priorities;

- A sustainable cyclical quality process should define the periodicity, implementation and evaluation process of the priorities;

- The Parliament should be put in charge of ex-post evaluating the national research priorities and their implementation by ministries, research institutions and companies;

- Communicate with stakeholders and with the public about the coordination and links between the national research priorities and other sectorial plans and strategies;

- Integrate the national research priorities in the Government's Five-year Plan;

- Create in the ANPR a priority-specific Pilot Committee involving and coordinating all the funders interested in each priority;

- Set up priority-specific implementation networks bringing together relevant research institutions and universities, researchers, intermediary organisations and end-users;

- Increase the involvement of universities in the implementation of the priorities:

- Creating university-level permanent research committees and involve them in the implementation of the priorities;
- Consider the existence of a university-level research strategy integrating the national research priorities as a criterion for the evaluation of the universities;
- Compensate the release of teaching obligations to encourage lecturers to dedicate their time to research projects in line with research priorities;
- Define a model to allocate the competitive research funding to the research team as well as to the lab and to the hosting institution (research institute or university) to cover indirect costs.

- Focus available resources to facilitate Tunisian participation in Horizon 2020 and Horizon Europe, joining international networks and projects in the identified priorities. The new bilateral research partnerships should also focus on these priorities; new spending rules for competitive research projects would notably increase the involvement of Tunisian research actors in these projects;
- Map (and contain) the scientific diaspora, boosting international collaborations in areas that are related to the Tunisian research priorities.

3 PROMOTING PRIVATE PARTICIPATION IN R&D

3.1 Valorising research results by creating stronger public-private cooperation

Business success both in industrialised and in developing countries depends crucially on the ability to develop, acquire and recombine knowledge from different sources, such as universities, and to use it to develop new products and processes (Muscio and Pozzali, 2013). The increasing reliance of the business sector on research institutions gained through international experience has been matched by a gradual increase in the so-called 'third mission' activities of academic institutions, which have been expanding their relationships with the private sector and society (Clark 1998; Etzkowitz and Leydesdorff, 2000; Gulbrandsen and Slipersæter, 2007). Therefore, businesses and research institutions are progressively learning to approach each other, gaining mutual benefits thanks to public-private partnership (PPPs).

In Tunisia's case, this process is struggling to take off; firms rarely collaborate with research institutions, and the latter struggle to engage with society and the private sector. A detailed analysis of the process of university-industry (UI) collaboration in Tunisia must take into consideration the complex interplay among factors hampering interaction between research centres and the private sector both at the institutional level (e.g. universities) and individual level (e.g. researchers). These are going to be illustrated in this chapter.

Tunisia is the top-performing country in Africa according to the Bloomberg Innovation Index ranking 43rd worldwide (South Africa ranks 48th and Morocco 50th), gaining two positions in 2018[16] and yet, research collaboration and business expenditure on R&D is very low. As explained elsewhere (Hassan, 2015; World Bank, 2017), different factors contribute to this situation. Tunisian authorities have been putting in place a few measures in favour of R&I activity, but several unresolved issues remain at the institutional and individual levels. In the following sections we address the most relevant issues.

[16]https://www.bloomberg.com/news/articles/2018-01-22/south-korea-tops-global-innovation-ranking-again-as-u-s-falls

3.1.1 Firms' absorptive capacity

A first contextual factor hampering business interaction with research centres and business R&D activity is the limited absorptive capacity[17] of Tunisian firms. **Because of the duality of the Tunisian business sector (see Section 1.2), the majority of economic activities are carried out by micro-enterprises while only a minority of large enterprises have their own R&D department.**

According to local stakeholders, while a small number of micro-enterprises has explicit demand for R&D services, large companies either do not engage in collaborations with research centres or interact with non-Tunisian partners. The micro-enterprise sector of the Tunisian economy is especially affected by low absorptive capacity. The UTICA estimates that Tunisia has some 4,500 enterprises with more than 10 employees, active mainly in the textile sector. In the opinion of the association, 10% of them is interested in innovation activity (approx. 500), therefore the potential demand for R&D services is quite limited. SMEs, especially those operating in traditional industries such as textile manufacturing, face structural limits in their access to external information on innovation opportunities and necessary competencies (Muscio et al., 2010). Their innovation needs must be interpreted and translated into innovation projects or collaboration programmes with external organisations (e.g. PPPs) responding to their needs. These aspects are potentially relevant for a country with such a large system of intermediaries such as Tunisia. In fact, especially in SMEs, the lack of innovation culture and scarce qualified personnel create the conditions for a latent demand for innovation to emerge.[18] In this case, company representatives know which areas need to be improved but do not have a clear technological solution in mind.

[17]Absorptive capacity can be defined as the organisational ability to identify, assimilate, transform and use external knowledge, research and practice (Source: https://www.oxford-review.com/oxford-review-encyclopaedia-terms/encyclopaedia-absorptive-capacity/).
Absorptive capacity determines the rate at which firms can learn and use scientific, technological or other knowledge that exists outside of the organisation itself. Therefore, it is a driver of firms' collaboration. In order to access knowledge, firms should improve their ability to learn from external sources. The ability to interpret and exploit external sources of knowledge is a critical factor in accessing new knowledge, and its lack can undermine firms' innovation capabilities. Cohen and Levinthal (1989, 1990) argued that the ability to exploit external knowledge is largely influenced by the level of prior knowledge, which includes basic skills, shared language and/or the most recent scientific or technological developments. All these factors point to some very important aspects of organisational learning and constitute what the authors label as 'absorptive capacity', which is generated by internal R&D activities as well as staff learning and training.

[18] Muscio et al. (2010) identify three main typologies of demand for innovation: Real demand – firms are aware of their needs and know how to act in order to improve their products/processes; Latent demand – firms have generic needs, limited capacity to translate these needs into potential innovation processes and are not aware of the technological solutions addressing its needs; Potential demand – firms does not express a specific need while the general conditions of the scenario (legal, technological, market) require them to do so. Firms' innovation needs are not explained because there are no firms in the area capable of responding to certain innovation challenges.

Secondly, this situation calls for **advisory services that guide companies in their choice of technologies and suppliers**. Businesses with latent demand for innovation clearly represent the bulk of the potential market for technological services provided by the Tunisian research system. However, there are companies that do not express a specific need even if they should do so. The lack of information and knowledge may prevent management from anticipating demand from current or potential customers (e.g. in response to regulatory changes) or simply to exploit a suitable and attractive innovative technology. Proactive policymaking is needed so that firms don't miss opportunities to develop innovative solutions to new or emerging markets.

These arguments refer to the concept of absorptive capacity (Cohen and Levinthal, 1989, 1990), which defines business capability to recognise the relevance and applicability of external knowledge. While external knowledge, and therefore collaboration, represents a vital source of knowledge for SMEs, improvements can only begin once firms understand there are external opportunities or solutions to existing problems.[19] As highlighted by Forfas (2005) in Ireland, this means there have to be internal cognitive capabilities, typically in the form of appropriately educated people with the character and training to see opportunities. These people have to be linked into the way the firm is managed in such a way that, when they see the value of external knowledge, this recognition can affect what the firm actually does.

Therefore, the above suggests that **domestic companies need support in improving their human capital**, **exploiting the large supply of graduates available in the country**. International evidence confirms that the probability of a firm having the capability to establish and maintain collaborations with universities, technology centres and other firms dramatically increases if the firm is endowed with qualified human capital and engages in R&D activity. Tunisian firms need to open up their innovation activity and upgrade their human capital in order to better exploit the positive externalities available to them in the national research system. In order to be able to establish and maintain linkages with external partners, Tunisian firms must improve their human capital, recruiting qualified staff and upskilling their employees (Muscio, 2007). Policy schemes are likely to be most effective if they focus on boosting skills and capabilities in companies (Arnold and Tether, 2001).

[19] There is empirical evidence that absorptive capacity significantly moderates firms' engagement and exploitation of a country's available research infrastructure and that the existence of technical centres is not a sufficient condition for technological development since the active role of a firm's strategies (interaction and openness to available sources of knowledge) is also needed (Hervas-Oliver et al., 2012; Muscio, 2007).

3.1.2 Conclusions and recommendations

In terms of policy implications, one way to address the limited absorptive capacity of Tunisian firms is to support companies in accessing the country's excellent supply of university graduates.

- A relatively cheap instrument would be the extension of traineeship schemes to all university subjects.

In fact, currently only some undergraduate programmes, such as business courses and engineering degrees, have compulsory traineeship programmes in their curricula. Traineeship schemes could also include a model where the traineeship would be based on an existing company problem/challenge or opportunity and implemented by an interdisciplinary team of students under the guidance of the university. At present, the MHESR is considering this option.

- Promote 'Ice-breaker' programmes making it attractive for firms to hire academically qualified personnel or, more generally, to upgrade their in-house skills (Lundvall, 2002).

One way to address this issue in the Tunisian context would be to promote policy measures, such as financial incentives,[20] for the recruitment of graduates. These programmes could be linked to subsidised consultancies and research services from research institutions and technopoles. Businesses interested in R&I initiatives could collaborate with research institutions on innovative projects (i.e. with the support of innovation vouchers) and benefit from the recruitment of graduates (see Section 3.2.4).

- The extension of the Mobidoc scheme to master's students may be a pragmatic way to support the introduction of graduates and post-docs, at least on a temporary basis, into companies.

While PhDs may have a narrow employment window (i.e. in top companies, with relevant R&D activity) master's students, on the other hand, have more scope to introduce novel approaches to business activity in a wider range of functions. Measures to increase the employment of graduates by Tunisian companies need to be complemented by measures that modernise and professionalise management, making it possible to exploit the perceptions of those best equipped to understand and translate external knowledge into business opportunities.

- It is necessary to raise awareness and interest among companies of the value of recruiting a researcher, and to help them find a suitable researcher who is equally interested in working for the company. Moreover, it would be advisable to integrate management training with innovation activities as learning-by-doing is typically much more effective than offering isolated training courses.

[20] Whether a tax credit or another form of subsidy is most optimal depends on the fiscal system.

While mobility and recruitment schemes seem like a relevant approach in Tunisia, given the ample supply of researchers and the limited number of targeted companies to begin with, these placement schemes require appropriate levels of awareness and matching activities and services to work properly.[21]

- The MHESR and MoI should facilitate the creation of virtual communities based on the implementation of the principle of Open Innovation,[22] focusing on 'technological' thematic areas with the support of the country's technopoles.

In order to better match demand and supply of technology, the creation of **Open Innovation communities**[23] must be promoted. Also the creation of communities[24] could be supported by the introduction of innovation vouchers (to be spent at technical centres or research institutions) (see Section 3.2.4). Innovation communities bring together, often in virtual spaces, stakeholders from the whole "quadruple-helix"[25] (government, industry, academia, and civil participants), strengthening cooperation among businesses (including SMEs), higher education institutions and research organisations, form dynamic partnerships and creating favourable environments for creative thought processes and innovations.

As already found in the case of developing countries in Asia (Fu et al., 2011; Yun et al., 2015), Open Innovation policies should not only fix market failures,

[21] In the case of Emilia-Romagna (Italy), the Spinner Programme promoted employment in R&I and enhanced the region's entrepreneurial culture (Ramaciotti et al., 2017). The scheme was effective in exploiting the region's research infrastructure. A key aspect of the initiative was the creation of a regional network of few 'Spinner Points' staffed by dedicated personnel, that acted as 'one-stop shops' providing an integrated supply of financial services (e.g. scholarships, financial incentives), advice and assistance, tutoring in business ideas development and training to improve human capital by upgrading skills. Spinner Points benefited from a pool of external specialists whose role was to provide bespoke advice to the teams of founders. The reason why a scheme such as Spinner could be relevant for Tunisia is that the country already has a large number of researchers skilled and human capital and a number of intermediaries and research institutions (and technical centres) that could work as spinner points. Implementation of a measure such as this would not require significant additional investment in new support institutions.

[22] The Open Innovation approach assumes that firms can and should use external ideas as well as internal ideas in addition to internal and external paths to markets (Chesbrough 2003). Many firms have started to implement this approach in the attempt to better face the changes in the competitive environment (Chesbrough, 2003). Recently, the concept of Open Innovation has been expanded from the micro-level of firms to the macro-level of NIS and innovation policy in general (Fu and Xiong, 2011; Lee et al., 2012; Santonen et al., 2011; Wang et al., 2012).

[23] https://eit.europa.eu/what-makes-successful-innovation-community

[24] These "communities of practice" are not merely a club of friends or a network of connections between people. They are built around a shared domain of interest. Membership to a community implies not just a commitment to the domain (e.g. the sector-specific technological problem) and a shared competence and/or interest in the domain that distinguishes members from other people. Members value the collective competence and learn from each other, even though few people outside the community may value or even recognise their expertise (see Wenger-Trayner, 2015).

[25] https://blog.innocentive.com/quadruple-helix-model-of-open-innovation

facilitating the matching between technology supply and demand, but also encourage a more active government role in enhancing Open Innovation at the level of innovation systems. In the case of many developing and emerging countries, the implementation of Open Innovation policies is different from developed countries in that there are neither enough linkages between innovative capability and absorptive capacity nor enough stocks in both factors. For example, China has a long tradition in supporting Open Innovation policies and practices (Fu et al., 2011) and has been especially aggressive in building Open Innovation networks.

- Hence, the creation of innovation communities should be supported by the support to innovation partnerships.[26] (See boxes for international practices).

Box 10: The Danish Ice-breaker programme

The Ice-breaker programme (*Isbryderordningens*) subsidised SMEs hiring unemployed academics. The programme was launched in 1994 on the basis of growing unemployment among academics and the lack of competence in smaller companies. As the unemployment rate for academics dropped again, the Ice-breaker scheme was targeted at something other than just general employment for academics. Special schemes have been developed for environmental auditing and management, as well as for foreign workers to access the labour market. The Ice-breaker project had two main purposes: 1) To promote the recruitment of academics through a wage subsidy for up to six months of up to DKK 11,000/month; 2) To introduce academics into smaller companies (<50 employees).

In addition, the scheme had several secondary objectives, including: initiation of development projects in the companies; and reduction of behavioural barriers in companies. The Ice-breaker programme received an overwhelmingly positive evaluation in Danish SMEs (AMS, 2003). The scheme was primarily used by companies in the manufacturing industry, which even before the initiation of the project, had the biggest problems in hiring academics. Most of the 'ice-breakers' were engineers. Business school graduates constituted the second largest group. Participating companies had lower economic performance than other companies in terms of annual turnover per employee, annual value added per employee and equity per employee, but they experienced a leap in competence through the appointment of the academic, which resulted in improved work routines, higher revenue and earnings, etc. In addition, the scheme led to an increase in general employment in companies (at all levels of education) without any substitution effect for staff with lower skills and education.

Source: Expert panel analysis, based on AMS, 2003

[26] For example, in the case of Belgium the KMO Innovation Vlaanderen (KIV) scheme targets SMEs with limited innovation capacity that are not yet engaged in research projects. The scheme provides subsidies for bringing researchers into SMEs, in partnership with research institutions. A research institution must collaborate with the SME to define the project and to propose a researcher to the company (see Arnold and Tether, 2001).

Box 11: Open Innovation Communities: the case of Lombardy (Italy)

As part of their EC-sponsored initiatives (Objective 1.2 of the ROP ERDF 2007-13), the regional administration of the Lombardy region in Italy promoted the creation of 'Open Innovation Lombardia', an initiative that aimed to establish a new model of regional innovation policy focusing on Open Innovation. The initiative was based on the creation of a web collaborative platform networking the regional entrepreneurial and research system to promote and accelerate knowledge transfer processes and innovation, facilitating the creation of innovation ecosystems consistent with the regional strategic priorities. The collaborative platform has reported a growing number of users (over 7,000 registered participants) over 200 communities including 85 related to Smart Specialisation Strategies.[27] Until October 2017, over 1,000 discussions had been initiated by platform users, more than 200 project proposals were launched and 430 expressions of interest submitted.[28] Open Innovation Lombardia was also used to distribute a questionnaire aimed at identifying relevant technological themes.

The Platform contains a set of tools and methodologies to support the creation of innovation ecosystems around strategic topics, identified earlier in the Smart Specialisation Strategy. The Platform is open and inclusive, with very low entry barriers while ensuring a good quality of transactions through a moderation process relying on facilitators and community managers supporting other participants when they become active, validating content. A reputation-based approach is promoted at all levels, limiting centralised activities to a minimum.

The Platform has contributed to the creation of several collaborative projects involving regional companies and research institutions in sectors ranging from ICT, to agriculture and textiles.[29]

Source: Expert panel analysis (2018)

[27] http://s3platform.jrc.ec.europa.eu

[28] http://www.openinnovation.regione.lombardia.it/it/eng/open_innovation-eng

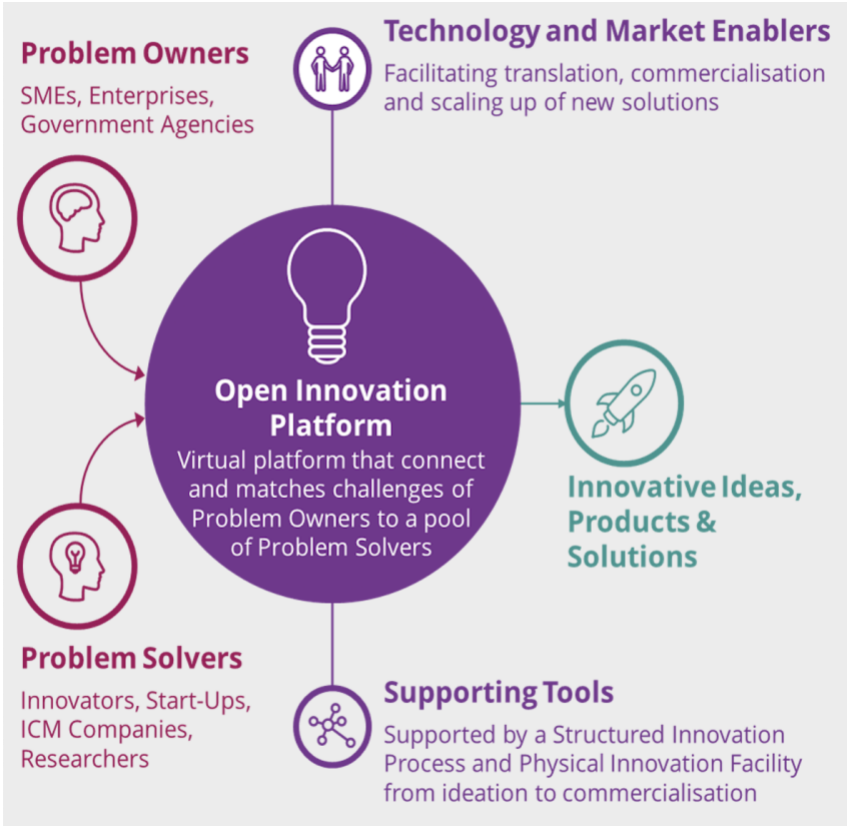
[29] http://www.openinnovation.regione.lombardia.it/it/eng/case_histories_eng

Box 12: Open Innovation Communities: the case of Singapore

A good example can be found in the Open Innovation Platform (OIP) promoted by Singapore's Infocom Media Development Authority (IMDA)[30]. The Platform invites both "problem solvers" and "problem owners" to register and join the virtual community. The authority launches innovation calls on the OIP every few months (Figure 3). Each Innovation Call comprises a set of challenges from different problem owners. Each challenge is accompanied with prize awards for winning solutions that are selected based on the criteria of problem owners. Problem owners provide prize monies for challenges they post on the OIP, as they have to signal their commitment to their innovation need, as well as encourage problem solvers to submit quality ideas and solutions. The Platform is built with the objective that that problem solvers who have successfully developed a solution through the OIP will continue to work with problem owners to deploy innovative products on a commercial basis. Where suitable, IMDA leverages existing funding schemes to support either problem owners or solvers in the OIP to further develop and commercialise their solutions.

Source: Expert panel analysis (2018)

Figure 3: Singapore's Open Innovation Platform



Source: www.openinnovation.sg

[30] https://www.openinnovation.sg/about

Box 13: Innovation Partnerships in Ireland and Italy

In Ireland the Innovation Partnerships Initiative provides financial support to encourage companies to undertake research projects with Irish universities and institutes of technology. The idea is that the company and the institution jointly define a research project of real commercial benefit to the company. For this purpose, it is useful to recall the creation of the Emilia-Romagna regional High-Technology Network,[31] which can be considered as a European best practice. In order to create the network[32] regional authorities needed to identify the local demand for R&D services and they did so offering financial support to companies wishing to carry out research projects in collaboration with regional universities. This provided the necessary information for the identification of local technological needs, which was later used by the regional agency for innovation and technology transfer ASTER to create working groups composed of university representatives, industry associations and other stakeholders. The working groups matched local competencies with local needs, defining the criteria for the creation of industrial research laboratories, which now involve researchers from several research institutions but specialised on the same research area.

Source: Expert panel analysis (2018)

3.1.3 Incentives to academic engagement

A second relevant issue hampering business interaction with research institutions emerged during the country visits is the magnitude of the **cognitive distance** (Box 14) between the research community and industry. While Tunisian stakeholders agree that innovation activity in domestic companies is limited by their low absorptive capacity, there are issues in the research system **that limit the incentive and capacity of researchers to engage with national firms**. As noted in the background report (Dani, 2018), industry contribution to academic research funding is marginal, while institutional funding for research in universities, research centres and technopoles is predominantly provided by the MHESR, with very small additional funding by other ministries (e.g. Ministry of Health and the Ministry of Agriculture). There is also little scientific co-publication because of a lack in funding of research and a lack in common interests. Some timid attempts have been made to connect research institutions to the private sector with initiatives such as 'PAQ Collabora'.[33]

US, British and Italian surveys show that faculty members consider the possibility of advancing their own research agenda as an important incentive for developing collaborations with firms (D'Este and Patel, 2007; Lee, 2000; Muscio, 2010). This suggests that universities and industry collaborate as long as both parties think

[31] https://www.retealtatecnologia.it/en

[32] The Network involves 82 laboratories and 10 technopoles operating around 6 thematic platforms.

[33] PAQ Collabora provides funding for collaborative projects (up to 300,000 TND for 3 years) between research institutions and enterprises within techno parks for R&D activities, for scale-up and improving prototypes.

that the activity will provide insights for the development of innovative ideas and new knowledge. However, in many Tunisian research centres researchers predominantly carry out their activities in relative isolation from the economic context. Researchers seem to have low incentives to collaborate with industry and, vice versa; companies largely ignore the potential positive impact of domestic academic research on their innovation potential. In this respect the economic literature refers to the concept of cognitive distance. If the cognitive distance is too great, it can hamper the process of communication between the parties and render knowledge transfer impossible.

From the business viewpoint, while the UTICA advocates better ways for businesses to do R&D projects together, it admits that industry and research institutions are mentally far from each other, underlining the aforementioned issues of cognitive distance. Even though businesses and academics would like to work together, they barely know how collaborations should work. In fact, in their view, while academics are focusing on publishing academic papers, they should try to adopt a problem-solving approach, understanding what businesses want and facing real-world situations. The Association claims that more moderation of the collaboration process is needed, even if there is agreement in the Tunisian community that, as discussed above, TTOs are empty shells with little or no competence to manage collaborations. The cognitive distance is also confirmed by the academic community, which stresses that businesses are reluctant to collaborate because they see university research as too far from their needs.

Interviews with Tunisian university stakeholders and technical centres confirmed that collaboration with industry is hard to establish because of issues at both the **institutional** and the **individual** levels.

Box 14: Definition of cognitive distance

Cognitive distance can be defined broadly as the degree of diversity in research methodologies and in the use and interpretation of knowledge between researchers in research institutions and private companies (Nooteboom et al., 2007). This distance can influence the process of technology transfer and collaboration. A certain degree of cognitive heterogeneity between the partners involved in a collaboration generally is considered to represent advantage in favouring knowledge pooling and, thus, the development of new and unexpected ideas (Von Hippel, 2005). In the literature, issues related to cognitive heterogeneity has been applied in the field of UI collaboration (Muscio and Pozzali, 2013). There are several areas where cognitive distance could have an impact on success and incentives to collaborate: 'choice of research thematic areas' addresses differences in the domain of knowledge; 'research methodology' refers to differences in the way in which specific problems are targeted, framed and solved; 'typology of pursued results' and 'criteria for selection of projects to be transferred to market' indicate differences between 'open science' and private sector norms; differences in 'timing of expected results' has been shown to be among the most important dimensions of cognitive distance in exploratory research on the differences in cognitive styles between academic and private researchers. These dimensions represent a barrier to the establishment of university-firm linkages and

influences the propensity for university-firm linkages. Repeated interactions with firms provide university researchers with a better understanding of the different norms, values, mental models and frames of reference that apply to the private and academic sectors. The experience of collaboration should lead to greater convergence in attitudes, making it easier to arrive at a common understanding of the different aspects of the collaboration process (Bruneel et al., 2010).

Source: Expert panel analysis (2018)

Institutional level

There are several institutional factors which, together with individual-level characteristics, may drive university involvement in knowledge transfer activities (Baldini et al., 2007). Institutional factors, such as the creation of a favourable/competitive environment for invention and commercialisation can greatly enhance collaboration. In Tunisia's case, this is particularly relevant because academic institutions, which are the main source of scientific knowledge, have not yet systematically adopted the 'third mission' in their activities.

There is little recognition (and incentive) in undertaking applied research, especially outside science, technology, engineering and mathematics (STEM). Some individual researchers make the effort, but this practice is not systematic. Tunisian researchers are focused on publishing as many scientific articles in recognised journals as possible because this is what defines their career. Confirming this attitude towards collaboration with industry, while Tunisia enjoys a lively student start-up community, there is very little spin-off activity by academics. According to stakeholders, it is too risky for researchers to step away from their research career. It is considered to be a conflict of interest if academics are also involved in spin-offs, in any manner.

Tunisian universities have yet to create a collaborative framework (agreements or eventual start-up processes), unlike in many other countries, such as Italy or Spain, where the rules and guidelines for research contracts, collaborative research and consultancies are well established (Caldera and Debande, 2010; Muscio et al., 2015; Weckowska et al., 2018). Hence researchers do not know how to act should the opportunity to collaborate arises. International evidence shows that adopting these rules has been associated with a boost in academic engagement. In general, university rules relating to conflicts of interest have a positive effect on the amount and size of R&D contracts. First of all, it is not clear if and how the financial resources (and incentives) raised from collaboration agreements are distributed to professors and to the administration of the parent institution. Secondly, little information is available about how potential conflicts of interest in academic engagement with industry will be managed, especially when marketing and selling the resulting technology or outputs (Bradley et al., 2013). Conflicts can arise on how to exploit results (via publications or commercial exploitation?) or how much time researchers should devote to traditional academic and teaching activities. Companies collaborating with universities may be looking for research results of immediate applicability to their production process, while researchers are focusing on publishable results. In other cases, there might be issues of timing of research activities, with companies requiring fast results and academics pushed by teaching duties to

delay contract research activities. Regulation related to conflicts of interest between researchers' teaching commitments and external activities can improve performance by reducing moral hazard problems and uncertainty in the appropriation of revenues from external activities.

Finally, as highlighted in Section 4.4, universities need a simpler structure and more autonomy in spending and raising resources (e.g. via the implementation of the EPST model). Yet it is a shared opinion among university managers that there is not enough capacity in universities to manage collaboration initiatives.

Individual level

From the researcher's viewpoint, issues of cognitive distance can be exacerbated by the lack of incentives in carrying out third-mission activities and in exploring the outcomes and consequences of collaboration with the private sector. While collaboration is currently possible with authorisation of the university, collaboration is not financially rewarded and is often discouraged by the administrative burden attributed to laboratories (see Section 4.4.1).

Firstly, **collaboration is not rewarding in career terms**: Openness to the socio-economic environment is not part of the criteria for hiring or for career appraisals. Third-mission activities are not considered in career progression and evaluation (spin-off, patents, fundraising, etc.). Secondly, when researchers or labs receive money, they have problems in spending it because of **low spending autonomy** (they need to be authorised by the Ministry of Finance). However, it must be noted that collaboration procedures are simpler when managed by technopoles as they are private entities. Thirdly, at present monetary incentives for researchers and/or labs to establish collaborations are not a common practice. There is no fixed rule on how much should go to the researcher or how it should be spent. This goes against international best practice in Europe and Africa (Kruss and Visser, 2017), which finds that academics, especially those working in research universities, need to be convinced of the potential knowledge value, academic benefits and financial incentives before engaging more with industry.

Because of these obstacles, it is a shared opinion in the Tunisian academic community that several academics by-pass their parent institutions in establishing 'informal' collaboration agreements.

Individual level: university IP

Another factor hampering researchers' interaction with industry is the Tunisian IPR system. In 2017 Tunisia ranked 77th in terms of total (resident and abroad) patent filing activity, but applications are mostly filed in non-resident offices (383 out of 555) (WIPO, 2018). Patent performance is very low with respect to peer countries in Africa, with only 48 patents per-million-inhabitant in 2017 vs. 133 in South Africa and 62 in Morocco.

Tunisia has an IPR system similar to the one established with the Bayh-Dole Act (1982) in the USA. This system establishes the "university-ownership-rights" principle. In other words, in the case of a researcher developing a patentable

innovation, the IPR stays with the institution and royalties from IPR are received partly by the researcher. However, there is inconclusive evidence regarding the impact of this model on country performance in terms of patent applications and spin-off creation (see Box 15).[34]

The attribution of ownership rights to universities offers little incentive for academics to patent and to commercialise innovations. While few universities offer the administrative structure to effectively boost the returns from patent activity (even in Europe, TTOs are rarely managed by somebody with a business background or employ staff with the range of competencies that would be needed), researchers will not perceive the direct economic benefits deriving from industrialising their inventions. Theoretically, the effects of changing from the individual level to university ownership centres on the arguments that this will raise the returns to universities from innovations that were developed onsite. In this line of thinking, university administrations and their TTOs are supposed to offer efficiency gains when marketing IPR as researchers are believed to be less capable than university TTOs in finding suitable industry partners (Verspagen, 2006) and in accurately determining the real value of their discoveries. However, as described in Box 15, the attribution of IPR to researchers can boost the innovation performance of research institutions. The attribution of ownership rights to universities increases transaction costs, adding red tape to the commercialisation process. In fact, while universities are interested in licencing and transfer of ownership of IP, some argue that inventions are rarely ready for commercialisation "off the shelf" and need the active assistance of the innovator to be developed (Jensen and Thursby, 2001).

In the case of Tunisia, researchers receive around 25% of royalty fees, but the exact amount is decided by the academic institutions themselves. This is consistent with the empirical "rule of the 25%" which is considered a "fair" royalty rate (Goldschreiber et al., 2002). But, as noted by Salauze (2011), this rule has recently been criticised by the US Court of Appeals which felt "it is a fundamentally flawed tool for determining a baseline royalty rate in a hypothetical negotiation" as it does not consider the risk associated with the inventors' investment and effort. Recent evidence found that inventor royalty shares serve as an effective pecuniary incentive at Portuguese and Spanish universities (Arqué-Castells et al., 2016). Evidence from a recent inventors' survey indicates that one-third of patent applicants are incentivised by existing royalty sharing arrangements and that another third would be incentivised by higher royalty shares.[35]

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[34] Weckowska et al. (2018) analyse the Spanish, German Swedish and Polish context, concluding that adopting Bayh-Dole-like legislation may trigger the development of local IP practices, which stimulate patenting. However, this legislation is not always sufficient and definitely not always necessary.

[35] As noted in Arqué-Castells et al. (2016): "Almost all universities in Portugal and Spain have their own regulations for the split of licencing income. The arrangements are freely chosen by each university and have to be approved by their respective management bodies. Income is generally allocated either to universities or researchers, but on occasions it can also be shared with the inventor's department or research group. The royalty shares in force in each university are reported in the corresponding intellectual property rights rules of the university. Changes in

Box 15: IPR issues

Several authors question the real benefits of the university-ownership-rights principle. In the US, the university ownership of patents promoted by the Bayh-Dole Act inevitably altered the research specialisation of the country, pushing universities to carry out research in those sectors that were more "patentable" (Rafferty, 2008; Shane, 2004). However, as stressed by Ejermo and Toivanen (2018), it is clear that university ownership of academic patents increased at the expense of patents invented by academic researchers but transferred directly to commercial firms. This evidence extends to many European countries, which have followed the example of the US. The Finnish case is emblematic: Finland adopted the university ownership principle only after a clear pre-reform announcement. Despite giving time to researchers and institutions to adjust to the new system, holding other factors constant, its adoption generated a substantial drop in patent activity. Supporting this, Conti and Gaule (2011) find that both in Europe and in the US TTOs' performance in terms of licencing income is constrained by the professor's privilege rule. However, the impact of this rule on academic entrepreneurship has probably been the opposite, disincentivising academics to spin off their inventions. In fact, Hvide and Jones (2016) find that, in the case of Norway, there was a 50% decline in both entrepreneurship and patenting rates by university researchers after the reform that introduced the university-ownership-rights principle. Therefore, even if the university-ownership-rights principle can contribute to an increase in university revenues from royalties and sale of patents, it does so at the expenses of sheer innovation activity (expressed in terms of patents) and of the creation of opportunities for research commercialisation and "post-sale" services by the researchers to industry.

In much of Europe, until the early 2000s default ownership of inventions by university researchers rested with the individual (Ejermo and Toivanen, 2018). Many European countries decided to imitate the US practice attracted by the sharp rise in university patenting that was observed at American universities in the 1980s and 1990s (Trajtenberg et al., 1997), following the Bayh-Dole Act. However, more recent empirical evidence has shed some doubts on whether these effects were due to a change in legislation or to other factors, such as the positive trend in global innovation activity, the growth of patent-intensive industries such as microelectronics, or to the drastic increase in patentable subjects and technologies (e.g. software, business methods, artificially engineered genetic organisms) (Hall, 2007).

Italy embraced the professor's privilege in 2005. While patent data disaggregated by type of applicant (i.e. academia vs. industry) is not readily available, in 2006, after the new regime was implemented, Italy registered a +17% in patenting activity.

Source: Expert panel analysis (2018)

their values have to be duly notified through changes in the intellectual property right statutes. […] Inventor royalty shares tend to concentrate at around 50%." (Arqué-Castells et al., 2016:1862)

3.1.4 Conclusions and recommendations

Tunisian researchers must be rewarded for the effort they put into interacting with the private sector. Career progression should reward academic engagement or, at the very least, should not penalise commercially-oriented academics. Several mechanisms can be exploited to reward faculties embracing these activities. In many countries the career progression of researchers is determined not just by teaching and research duties but also by considering academics' involvement in third-mission activities.

- Career progression could be based on weighted performance indicators that consider not just teaching and publications but also co-publications with external researchers (both from other research institutions and industry), patent applications, licences of university-generated IPR, and external fundraising (from government bodies and industry).

For example, weighted indicators for career progression within each scientific discipline could include: teaching indicators (teaching hours, supervised students, etc.) (~30%); research indicators (publications in ranked journals, co-publications with researchers in other institutions, patents, etc. (~30%); third-mission and institutional activity (institutional roles such as PhD course coordination, licences, collaboration agreements, etc.) (~30%); and seniority (~10%). Therefore, researchers that are more inclined towards engaging with the private sector are not penalised in terms of career progression. Considering patents, licencing and commercialisation activity by faculty as an important consideration for merit, tenure, and career advancement, along with publishing, teaching, and service (Sanberg et al., 2014) are an important step towards increasing Tunisian academic engagement with the private sector and society.

- Research institutions should offer faculty members **monetary rewards** for their licencing activity.

The attribution of such rewards or benefits would be linked to the concession of more autonomy to research institutions (see section 4.3). In fact, while the 'third mission' should be put at the core of university assignments, the distribution of monetary benefits should go hand-in-hand with the aforementioned attribution of **more autonomy to universities**. If universities had more autonomy, they could reward academics for their commitment to third-mission activities such as licencing with the attribution of research funding and/or bonuses, royalties, etc.

Current policies in Tunisia at best tolerate commercialisation efforts. Hence, only few very persistent academic entrepreneurs with extremely successful ideas will consider continuing their careers along these lines, despite the lack of rewards.

- Universities should be encouraged to set **academic rules** on how faculty members should behave in the case of academic engagement, as academics need to access a taxonomy of activities that can be considered as research commercialisation or, more generally, academic engagement.

Thanks to these rules, researchers willing to engage in collaborations and/or technology transfer will be informed on how to get started and who to contact

should the opportunity arise. A list of potential areas covered by these rules is presented in Table 5.

- The attribution of bigger incentives to researchers should be matched by a reform of the current IPR system.

The royalty fees currently retained by the institution are too high for a country that aims to stimulate the sheer number of interactions rather than increasing the returns to universities from a few "blockbuster" inventions. While there are no figures, university representatives argue that collaboration activity does happen in informal ways as academics are not allowed the double salary and find the procedures to establish collaboration agreements with businesses too complicated. Lower withholdings and leaner collaboration procedures would incentivise the establishment of PPPs.

Moreover, there are some concerns about the applicability of the university-ownership-rights model to the Tunisian context. It would seem more appropriate to reform the country's IPR system in favour of the adoption of the so-called professor's privilege, which grants to university professors and researchers exclusive IPR to their inventions. It allows academics to decide whether to patent and how to commercialise their discoveries, even if the underlying research is supported by public funds. Finally, while the professor's privilege grants higher levels of entrepreneurship (Bengtsson, 2017), any reform of the IPR system should go hand-in-hand with appropriate investments in TTOs.

A recent example of **professor's privilege** that is particularly suitable to the Tunisian context can be seen in the Swedish case (Box 16). Tunisia should consider the adoption of this principle of IPR distribution.

Table 5: Areas of pertinence of academic internal rules

General rules	These rules should provide general basic information such as 'man-day' rates for staff at any level (technicians, research officers, researchers, associate professors, full professors, etc.), who retains the IP generated (The inventor? The university? The company?), the period of leave granted to academics venturing into a spin-off company.
The conflicts between teaching, research activity and the third mission	These rules should regulate conflicts between the academic and the institution or between her/his multiple tasks. For example, they should tell academics how many days/hours they can dedicate to third-mission activities per academic year, which of the three academic missions should be prioritised in the event of collaboration agreements (e.g. when collaboration agreements require work during teaching semesters), whether or not they can drop teaching courses if involved in particularly demanding projects.
Financial withholdings and monetary incentives	These rules should indicate clearly how revenues from collaborations and lab tests are distributed within the institution (share of withholdings attributed to the university/faculty/department/lab), charges for the transfer of IP, and the eventual imposition of limits on individual compensation (e.g. no more than the yearly wage).

A section sets the financial norms and incentives: the amount of money retained by the university (fixed or variable fees), the distribution of resources between centres (the university, the department, the lab/centre, the tenured and untenured researcher/s. This section can contain information regarding the imposition of a limit (ceiling) on extra remuneration to researchers and administrative staff involved in external consulting activity (e.g. not higher that the yearly wage, per year). Another section sets the rules on conflicts of interest related to teaching and external activities. Sometimes there is information on the exclusion criteria. Finally, these documents can include information on the university charges for the transfer of IPR, university withholding of royalties from the sale of IP and the share of royalties paid to inventors. These rules mark the autonomy of Italian university in moderating the professor's privilege (see Box 17) set by the national law.

Box 16: Good practice in academic knowledge transfer: Sweden's professor's privilege

In Sweden, academics own the rights to their own research as long as nothing else is agreed (teacher's exception). The professor's privilege applies to students as well as professors. In 2004, the Swedish government commissioned an analysis of the professor's privilege in response to discussion of the "Swedish paradox". At the time, Sweden was a world leader in per capita R&D expenditure and yet its economic growth lagged the average for OECD countries. The country was a leader in terms of patents and scientific publications per capita, which should have positioned it well for entrepreneurial-led growth (Braunerhjelm, 2007).

The 2008/2009:50 Government Bill acknowledged the results of the survey, asserting the importance of the professor's privilege. In maintaining the privilege, the bill stressed its relevance in providing the incentives for researchers to commercialise their inventions (Färnstrand Damsgaard and Thursby, 2013). It stressed that without adequate university systems for commercialisation and mechanisms to ensure adequate incentives for researchers to take part in the process, the privilege should be maintained.

In principle, the professor's privilege should provide university employees the necessary incentives to commercialise their inventions. The professor's privilege also means that researchers have full responsibility for creating additional value from their research and results, even when they are supported by their institutions.

Comparing the US and the Swedish systems, Färnstrand Damsgaard and Thursby (2013) find that the former is less conducive to entrepreneurship than the Swedish system if established firms have some advantage over faculty start-ups. Further, the average probability of successful commercialisation can be somewhat higher in the US. However, if there are search costs in finding an established firm (such as in the case of countries with an underdeveloped industrial base), if the inventor prefers basic research (as in the case of many Tunisian universities), or if there are close to constant returns to scale in development effort, and any of the three is combined with a general advantage for the established firm, then the average probability of commercialisation success is higher in Sweden.

Finally, According to Bengtsson (2017), in the Scandinavian case, while Danish and Norwegian university TTOs (which are subject to the university-ownership-rights principle) have recently increased their use of the licence commercialisation strategy, Swedish TTOs have maintained their use of the spin-off commercialisation strategy. The relative use of the two commercialisation strategies, licencing and spin-offs, is indirectly influenced by the IPR framework, while it is more directly influenced by university strategies, the government funding system, the TTOs access to business development resources, and competence and monitoring of the university TTOs.

Source: http://www.uuinnovation.uu.se/develop-your-idea/

Box 17: Good practice in knowledge transfer: Italy's academic rules on academic engagement

In the last ten years, the vast majority of Italian universities implemented the so-called "regolamento conto-terzi". These strategic documents were adopted without any input from the central government. A few universities pioneered this practice and they were immediately followed by the others. The implementation of this set of academic rules on academic engagement, together with similar rules dedicated specifically to academic spin-off activity ("regolamento spinoff"), had a discernible impact on UI interaction (Muscio et al., 2015).

These documents set specific rules of conduct for academics in several areas of researcher engagement with the private sector, such as incentives for academic staff, conflicts over IPR, withholdings of revenue from the central administration, etc. The formats used by universities are similar and typically include a definition of the types of regulated contracts (e.g. research contracts, lab tests, etc.).

Sources:

http://www.unife.it/ateneo/organi-universitari/statuto-e-regolamenti/allegati/regolamento-delle-prestazioni-conto-terzi

http://www.normateneo.unibo.it/regolamento-delle-prestazioni-conto-terzo-e-del-compenso-aggiuntivo

3.2 R&D spending, innovation, start-ups and support structures

3.2.1 R&D spending and innovation in Tunisia

In Tunisia, R&D spending is highly tilted towards the HE and government sectors. R&D activities in the business sector represent some 20% of all expenditures. The Tunisian government is willing to increase R&D expenditure, and this is evident for those areas that are under direct control of the government: HE and public research institutions.

Table 6: Gross expenditure on R&D by source of financing

	State (%)	Higher Education (%)	Companies (%)	Private non-profit institutions (%)	Abroad (%)	Non specified (%)
Iran	61,6	7,4	30,9	..	..	..
Iraq	100	a	..	n	n	n
Israël	12,2	2,2	36.6	1,7	47,3	..
Koweit	94,2	..	5,2	N	1,2	..
Malte	34,4	1,4	46,6	0,3	17,3	..
Maroc	23,1	45,3	29,9	..	1,7	n
Oman	41,6	32,1	4,6	n	n	21,7
Tunisie	65,0	a	20,0	n	14,9	n
United States	33,4	3,0	60,0	3,6	a	..
UE-15	32,9	0,9	55,6	1,7	8,9	..

Source: UNESCO, Eurostat, Hassan (2015).

Notes: 2012 or latest year available. Due to sifnificant methodological differences, data from many countries are not fully comparable. a=data included in other categories. n=nil or negative. EU=15, Malta:2012. United States, Iraq, Oman, Kuwait:2011. Israel, Morocco:2010. Tunisia:2009. Iran:2008. Data on the state sector in Iraq and Tunisia include data on higher education. Foreign financing data for the United States are distributed among the other sectors. Data non specified for Oman are UNESCO estimates. Data for Tunisia national estimates. Data for the United States are provisional.

While there is an argument that the public sector has to lead the way in terms of increasing R&D spending in developing countries, the nature of increased public efforts (i.e. basic or applied research in collaboration with companies) makes a big difference in economic terms:

- Investing in basic research only provides high returns in the country of origin if there is somebody that can take up the results and bring them to fruition via incorporation in products and services. Otherwise – and only in the case that the research is of high quality – the results of basic research might be employed somewhere around the globe usually with little spill-overs for the country of origin.

- Applied research might have a bigger likelihood of being incorporated in products and services and may also help a country to benefit from the global pool of available basic research by increasing absorptive capacities. This increasingly demands some R&D spending in the business sector or at least

more cooperative innovation efforts between science and industry. Without these, it is highly unlikely that a country can tap the available knowledge.

In Tunisia, research is done predominantly in the public sector in the form of basic research and researchers are overwhelmingly absorbed by the higher education sector (see Section 1.2). Because of this structure – high on basic research with researchers strongly concentrated in the HE sector – there is little knowledge transfer activity and scientific research barely contributes to Tunisia's economic development.

The present budgetary situation in Tunisia suggests that research has to aim at more immediate returns and, consequently, become more applied and applicable. The intention to increase BERD and to strengthen UI collaboration are important steps in this direction. This calls for an alignment (in terms of quality and quantity) of the supply of graduates by the education system and demand from the economy and public sector. The high unemployment rate of graduates is an indication that qualifications are not in line with company needs and that the absorptive capacity of the higher education and government sector is low. **Improving the employability of graduates would thus be an important step towards increasing R&D activities in companies** because well-trained graduates transfer knowledge and know-how and help to set up (internal) innovation projects, while improving labour market conditions for graduates.

At the same time, it is important to accept that the first steps into R&I activities often do not require highly qualified researchers but **well-educated technicians** and **engineers** (see Kriaa and Karray, 2010; El Elj, 2012). To understand the demand side and the supply side for skills and roughly predict how this will evolve is of utmost importance for managing and changing the structure of graduates in the higher education sector.

Reorienting public R&D efforts towards more applied research in order to increase the relevance of collaboration between science and industry also increases the likelihood of companies investing in research and innovation. In addition to the hindrances already mentioned, the present lack of R&D collaboration between science and industry is also due to "cultural roadblocks" between science and industry, which result in infrequent interaction and poor understanding on both sides of what companies, research institutions, researchers and graduates could bring to the table. Building trust and thus increasing the willingness to interact with other groups have to be developed.

Given this assessment, increasing R&D in companies or their investment in collaborative research is not a one-sided activity that focuses on companies alone, but rather a task to refocus the system overall.

Any strategy that aims at increasing R&D should set out targets that define the level to be achieved and the speed of change. Still, there is no way to determine the optimal distribution in financing R&D between private actors and the public sector. Empirical evidence shows large heterogeneity in the public share in R&D financing for countries playing catch-up (see Table 6). In the US and Europe about one-third of R&D expenditures is provided by the state. Israel – while being

one of the highest R&D spenders – relies on only 12% of R&D expenditures from the public sector. The private sector contributes about 60% or more to the overall spending in advanced countries. The level of private spending is heterogeneous in struggling countries. Malta has a 47% contribution form companies while it is about 5% in Kuwait and Oman. Tunisia is right in the middle of this distribution with a 20% contribution by companies to total R&D spending.

BERD accounts for 20% of GERD, which corresponds to 0.136% of GDP. According to the World Bank, total R&D spending in Tunisia stood at 0.68% of GDP in 2012. Thus a 10% increase of R&D spending of companies would increase overall R&D spending by 0.014% points, bringing it to 0.69% of GDP. This increase can only happen if all other factors hold (e.g. no GDP growth). Thus, increasing the share of private R&D measured as a percentage of GDP demands growth rates that are higher than the growth of the economy and the public share. This is definitely demanding but is a realistic objective, as many successful "catching-up" countries have already demonstrated.

The first step towards such a development process would be to know the real numbers on R&D spending in the Tunisian private sector. The present figures are estimates and not based on surveys. No break down by sector, size class etc. is available. The real numbers might be lower or higher. Consequently, setting a target for R&D spending and formulating policies to achieve this target is guesswork and not helpful.

We found three sources that have potential to fill some knowledge gaps on private R&I spending and performance in Tunisia: 1) a survey by the World Bank contains R&I-related indicators for 2013; 2) the Tunisian innovation survey conducted in 2005 sheds some light on innovation behaviour; and 3) the number of applications for Tunisian R&D support programmes might hint at the number of R&D-performing companies in Tunisia. Analysis of the data leads to the conclusion that there is not enough evidence to formulate a baseline or target efforts to increase BERD. All three sources mentioned have severe limitations, as they are either strongly biased towards innovative firms (World Bank and innovation survey samples) or incomplete in the sense that only a fraction of R&I-performing companies participated in R&D-focused support programmes. On the contrary, if – as some claim – all R&D-performing companies participated in these programmes, then the sheer number of Tunisian R&D-performing companies would be far lower than indicated in the World Bank survey and in the 2005 innovation survey (see the detailed analysis in Appendix A).

However, the econometric modelling of innovation survey data still offers some insights into the innovation behaviour of Tunisian firms:

- R&D-performing firms tend to have a higher probability to innovate. Past innovation experience and firm size also have a positive and significant impact (Kriaa and Karray, 2010). This positive relationship between R&D spending and innovation is confirmed by El Elj (2012) as well as the positive impact on the absorption capacity of firms.

- Cooperating with universities, research institutions, foreign companies, etc. also increases the likelihood of innovations (El Elj, 2012).

- Company ownership influences innovation performance: companies partially or fully owned by the government have a lower probability of innovating than private companies. Moreover, foreign-owned companies are less likely to innovate, indicating that they are mostly engaged in outsourced production activity, which is based on imported technology and capitalising on low wages (Kriaa and Karray, 2010). Export intensity and foreign ownership also have a negative impact on innovation, according to El Elj (2012). This picture is somewhat more complicated for R&D expenditure: while there is lower R&D spending in innovation-based companies with foreign ownership, R&D expenditure for non-innovation companies with foreign ownership is higher. This hints that some R&D is needed to absorb the technologies used in the production process. The same relationship holds for companies with partly or fully public ownership. The latter carry out most R&D activities in Tunisia.

- Surprisingly, the quality of the labour force does not seem to increase innovation as innovative firms have less skilled personnel (Kriaa and Karray, 2010). El Elj (2012) finds that low- and medium-sized tech firms tend to innovate more but do need less skilled employees for their innovations that are (quite often) not based on R&D. The role of managers and qualified executives seems to be focused on running operations rather than introducing innovation.

- Own R&D spending allows firms to capitalise on in-sector spill-overs while decreasing R&D spending overall. Non-R&D investing companies benefit very little from spill-overs.

The insights provided by Kriaa and Karray (2010) and El Elj (2012) seem plausible even if the dataset used is quite old. The findings corroborate other research on innovation behaviour in catching-up countries and thus form a basis for developing policy measures. Nonetheless, the data used here highlights that more up-to-data and representative surveys are needed to draw the right conclusions for intervention and to better monitor progress.

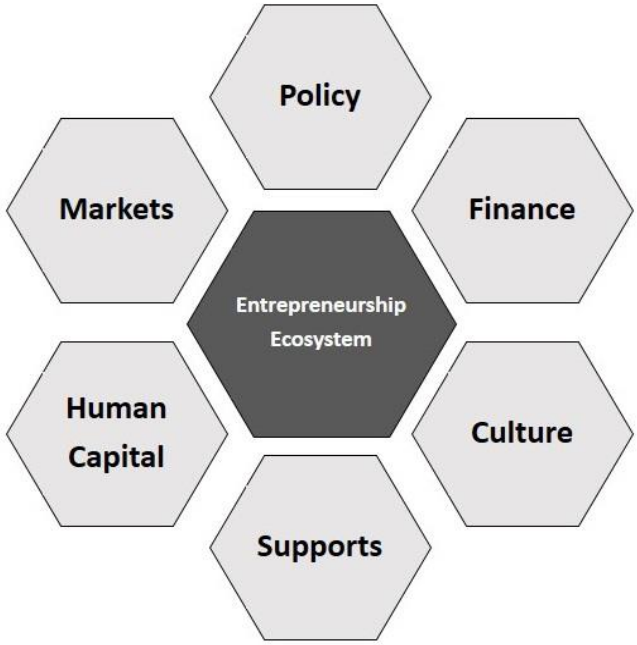
3.2.2 The Tunisian start-up ecosystems: start-ups, R&I

Start-ups have been increasingly viewed as an important source of economic growth and employment by introducing vastly improved products and processes as well as disruptive innovations. Start-ups are also a means of transferring knowledge out of HE institutions and to increase science and knowledge-based innovation strategies where R&D investments are part of the process. Consequently, many countries have started developing start-up ecosystems to harness the desired outcomes of increased start-up activities. Start-ups are also seen as "game-changers" in tackling societal challenges. This may either be more environmentally friendly products, services or business models or the social impact of entrepreneurs.

The start-up "movement" is not restricted to advanced countries but unfolds also in less developed countries, where bottom-up initiatives created working

ecosystems. The start-up ecosystem concept has emerged as a means of studying, explaining and managing entrepreneurship at a regional level, focusing on the interaction of different actors and conditions. It can be defined as "a set of networked institutions […] with the objective of aiding the entrepreneur to go through all the stages of the process of new venture development. Fully-fledged start-up ecosystems can be understood as a service network, where the entrepreneur is the focus of action and the measure of success" (Andrez et al., 2016). The constituting elements of each start-up ecosystem are (public) policies and framework conditions, finance and support mechanisms and measures, markets, human capital, and a specific culture (see Figure 4). Despite similar building blocks, start-up ecosystems are very heterogeneous building on local specificities and actors and ruling out – prima facie – one-size-fits-all strategies to help them flourish.

Figure 4: Dimensions of start-up ecosystems



Source: Isenberg (2011)

In Tunisia, start-ups have been on the policy agenda for a long time. They are seen as instrumental agents of structural change, i.e. a potential starting point for a more knowledge-intensive mode of production and as an opportunity to reduce the high number of highly qualified university graduates that are unemployed (see APII, 2016).

Still, the understanding of a start-up system has largely changed since the 1990s. Nowadays, start-ups are newly established companies often related to IT that aim at developing a scalable business model, while – historically – the simple establishment of new companies at universities or technology parks was on central stage. Tunisia's start-up scene has largely developed independently

alongside the public structures and has continuously grown in the past years. It is now one of the most evolved ecosystems on the African continent. The Global Entrepreneurship Index (GEI) which measures both the quality of entrepreneurship and the extent and depth of the supporting entrepreneurial ecosystem, ranks the Tunisian start-up ecosystem 40 out of 137 countries surveyed (Zoltan et al., 2017). Tunisia has moved up two spots since the GEI 2016. The dynamics of the start-up system are reflected in a constantly increasing number of start-ups. According to "entrepreneurs of Tunisia" – a crowd-sourced online interactive platform that measures the impact of the Tunisian Start-ups on the local economy and tracks the ecosystem evolution – 386 start-ups were legally constituted in the past seven years. According to the GEM report Tunisia 2012 (Belkacem and Mansouri, 2013), the typical entrepreneur is male and between 22 and 44 years' old. The share of female entrepreneurs is at 30%. A total of 36% have a secondary degree, and 23% a tertiary degree. The new enterprises are most often micro-enterprises that employ less than five people and are spread across several sectors: commerce and tourism (28%), agriculture and fishing (24%), manufacturing (14%) and non-manufacturing industries (5%) (Belkacem and Mansouri, 2013). A recent study by TS Index (Le Manager, 2018) claims that 60% of start-ups are exporters, particularly to North Africa, the Middle East and to the European market. Start-up activities are not evenly spread across the country. In general, start-ups flock to large, flourishing agglomerations. Tunisia is no exception to this pattern: most start-ups are located in Tunis and Sfax, two of the richest cities in the country (see Figure 6 on the local business climate), although the government actively promotes start-ups in remote areas.

The latest step in the evolution of the Tunisian start-up ecosystem was the Start-up Act 2018 that was lobbied for by entrepreneurs for almost two years. It aims at putting sectors with high-growth potential, like science and technology, at the heart of the country's economic transformation instead of traditional sectors such as tourism and agriculture. It intends to provide better access to finance for nascent businesses, to reduce the number of bureaucratic procedures required to register and start a business, and promises to facilitate access to imports and exports. To have access to this mechanism, the Start-up Act comes with the following criteria defining start-ups (see Il Bboursa, 2018): the start-up company must be less than ten years' old, employ fewer than 100 people, have a revenue below €10,000 and at least two-thirds of its capital must come from founders. A strong business model and innovative products of services as well as a focus on technology and potentially high growth are also required.

The Start-up Act (2018) provides a set of benefits for so-called *start-upeurs*:

- Employees of public or private enterprises having more than three years of experience launching their start-up will be granted a one-year leave (congé pour création d'entreprise);

- The founder-shareholder will receive a grant in the first year based on his/her previous salary or a standard allocation in case of unemployment;

- Any young graduate is eligible for employment programmes (SIVP, contract of integration of graduates of HE) in accordance with the legislation in force.

Those who create a start-up may receive this support for up to three years after setting up the start-up;

- The Ministry for the Digital Economy will support founders when filing and registering patents with national and international authorities based on an assessment by the organisation responsible for industrial property in Tunisia;

- During the launch period, start-ups are exempt from income tax and from social security payments for employees (State support for employee and employer costs).

In addition to public support initiatives, a large number of non-governmental organisations contribute to the creation of new companies through the popularisation of an entrepreneurial culture, and training for personal skills development (see APII, 2016). These include associations and institutions such as *Le Réseau Entreprendre Tunisie,* ENPACT, ELSPACE, Cogit, Education For Employment-Tunisie (EFE-Tunisie), and INJAZ-TUNISIE.

With the financial support of international donors (e.g. European Union, United Nation Industrial Development Organisation, Qatar Friendship Fund QFF, Mercy Corps), new support programmes that range from providing access to finance to establishing co-working space, incubators and accelerators were initiated (see Appendix E for more information).

The public support for newly established companies and start-ups has resulted in a large number of public incubators and support programmes. Many of the latter are not start-up specific in the sense that most of the companies hosted are simply newly established companies that do not pursue a scalable business model – one of the main features of a start-up. At the end of 2017, the public National Network of Business Incubators (RNPE) counted 27 business incubators that are related to an academic institution (see Table 7). They hosted 118 enterprises, 73 of which were created in 2017. The total investment is 7,163 million TND and 516 jobs were created.

So far, there seems to be a contradiction between the number of support programmes – which is large – and the amount of public funds that are funnelled into the start-up ecosystem – which seems small (see for more information Appendix C). Also, there is no harmonised and up-to-date approach to how start-ups are nurtured in public incubators. The international start-up scene has learned to rely on the lean start-up approach which helps to minimise risks of entrepreneurs, speed up the development time of start-ups and reduce the resources needed. The mentoring and support at well-functioning incubators provides services along these lines.

Table 7: Business incubators in Tunisia

Incubators
Nabeul Elan Technologique (Pépinière)
Sfax Innovation (Pépinière)
Gafsa Technologie du Futur (Pépinière)
Gabès Promotech (Pépinière)
Radès Technologie Plus (Pépinière)
Nabeul Elan Technologique (Pépinière)
Sfax Innovation (Pépinière)
Gafsa Technologie du Futur (Pépinière)
Gabès Promotech (Pépinière)
Radès Technologie Plus (Pépinière)
Sousse Tech (Pépinière)
Kairouan Innovation Technologique (Pépinière)
Pépinière des Initiatives Innovantes Ksar Hellal
Le Kef Essor Technologique (Pépinière)
Jendouba Créatic (Pépinière)
Djerba Création et innovation (pépinière)
Mahdia Entreprendre (Pépinière)
Centre d'Innovation et de Développement (INSAT Pépinière)
Carthage Innovation (EPT Pépinière)
Zaghouan Terre d'Entreprendre (Pépinière)
Pépinière de Bizerte
Pépinière de Kébili
Pépinière de Siliana

Incubators
Pépinière de Manouba
Pépinière de Béja
Pépinière de Sidi Bouzid
Pépinière de Kasserine
Pépinière de Tataouine
Pépinière de Tozeur
Pépinière de Sfax2
Pépinière de Soft Tech SousseTech (Pépinière) Sousse

3.2.3 Innovation support in Tunisia

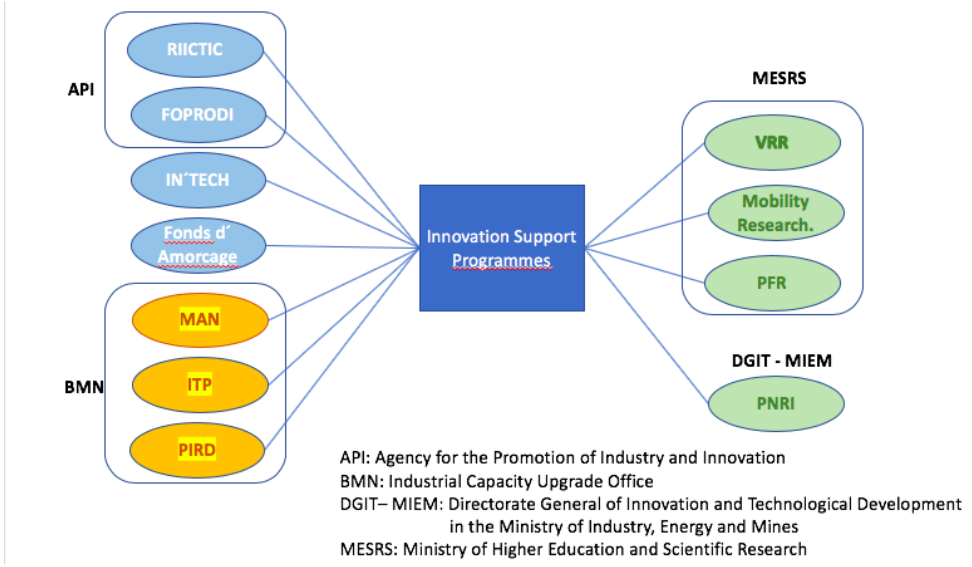
This sub-section gives a brief overview of the most important institutions and measures that are promoting R&I in the private sector. It is not intended as an in-depth analysis of the Tunisian structures and activities (see Hassan, 2015), but rather the most salient features of the system are highlighted and some of the (institutional) bottlenecks are identified.

Financial support activities for R&I can be roughly divided into direct (e.g. grants, loans) and indirect financial (tax reliefs in various forms) support and measures that improve overall access to finance (e.g. start-up funds, risk capital) and thus also work as a catalyst for innovation and R&D financing. The support for R&I in Tunisia relies to a substantial degree on direct financial support. There are no indirect financial support schemes (e.g. tax credit) for R&I activity, but a substantial number of schemes that are supposed to ease access to capital for innovative Tunisian businesses.[36]

Figure 5 presents an overview of support measures, the topics addressed, and institutional responsibilities in Tunisia. The programmes are grouped according to their objectives which are providing finance (RIICTIC, FOPRODI, IN'TECH, *Fonds d'amorcage*), direct innovation support in a narrow sense (MAN, ITP, PIRD) and collaboration between companies and scientific or technology transfer organisations (VRR, *Mobilité Chercheur*, PFR, PNRI). The left-hand side of Figure 5 is under the auspices of the MoI and its agencies API and BMN, while the right-hand side is mostly governed by the MHESR. PNRI – which is governed by the DG of Innovation and Technical Development at the MoI – is the exception to this "rule".

[36] For an in-depth review of the system, see Hassan (2015).

Figure 5: Overview of innovation-related support programmes in Tunisia



Source: APII (2016) adapted by the authors.

Among the direct financial company support measures, only the PIRD, the PNRI, the ITP and the RIICTIC were intended to finance R&D and industrial innovation. Although other programmes target R&D to varying (mostly low) degrees, we focus on the following schemes:[37]

- ITP – Investissement Technologique Prioritaire (investments in priority technologies) supports enterprises in operation for at least one year with growth potential and not in economic difficulty that operate in manufacturing, industry-related service activities (e.g. computer services, design, consultancy, maintenance and industrial maintenance services, publishing, communication). ITP offers 50% premia for both tangible and intangible investments. The upper ceiling for tangible investment is €31,250 (100,000 TND) and €21,875 (70,000 TND) for intangible investments. Companies may apply every five years for the premia.

- PIRD – Grant for investment in research and innovation (Prime d'investissement en recherché et innovation) – was created in 1995 and supports feasibility studies necessary for the development of new products or new production procedures, experiments and technical tests of prototypes as well as field experiments and the acquisition of scientific laboratory equipment necessary for the conduct of R&D projects. Public and private institutions and companies operating in manufacturing, agriculture and fishery, computer

[37] PMN is overwhelmingly supporting investments and thus the catching-up process of Tunisian manufacturing. Although intangible investments like R&D are not excluded, only a small fraction of overall expenses would be considered supporting R&I (Hassan, 2015; Khanfir, 2015). For this reason, it is not added to this list. The other programmes mentioned in Figure 5 are described in some detail in Appendix E on the start-up ecosystem.

engineering, design, health and environmental services may apply to get 50% of the total cost of studies with a maximum premium set at €7,813 (25,000 TND). PIRD also cover up to 50% of costs related to experiments and technical tests of prototypes, field experiments, and the acquisition of scientific equipment for laboratories necessary for conducting R&D projects and applied research projects. The upper cost limit is €31,250 (100,000 TND).

- PNRI – The national programme of research and innovation (Programme National de la Recherche et de l'Innovation) aims at strengthening the cooperation between industrial enterprises, R&D structures and sectoral technical centres in the field of applied research, and innovation. The technical centre is the main actor in PNRI projects being responsible for management, monitoring, and to a substantial extent implementation efforts. The programme finances R&D, innovation projects, improvement of industrial capacities, and the modernisation of production processes. The programmes finance up to 80% of the R&D expenditures worth up to €62,500 (200,000 TDN).

- RIICTIC – Incentives for creativity and innovation in information and communications technologies (Regime d'incitation à la créativité et à l´innovation dans le domain des technologies de l´information et de la communication) supports high value-added eBusiness projects. The project helps Tunisian individuals and companies which intend to set up eBusiness projects whose costs do not exceed €62,500 (200,000 TND) for individuals and €156,250 (500,000 TND) for companies. Extension projects with a cost not exceeding TND 500,000 may also receive funding in the form of a refundable grant (up to a maximum of 49% of the minimum capital of the project, without exceeding €37,500 (120,000 TND), study and technical assistance grant (70% of the total cost of the study and technical assistance, up to a maximum of €3,250 (10,000 TND), a material investment grant (10% of the total cost of equipment, up to a maximum of €6,250 (20,000 TND), or a premium for intangible investments (50% of the cost of intangible investments capped at €18,750 (60,000 TND)).

The most striking differences between these categories of support programmes is the "deal flow". In 2013, investment-oriented programmes distributed about 36 million TND while the innovation-oriented programmes paid out 0.6 million TND. Thus, significantly more resources went into investment promotion than innovation support, which clearly demonstrates the present focus of support activities. The contrast is even stronger when looking at the number of applications that were supported. In 2014, more than 900 investment projects were financed (PMN + ITP) while only 10 innovation projects received support (PIRD + PNRI). The number of supported proposals was somewhat higher in the years before 2014, peaking at 20 supported projects in 2013 (see Table 9).

Table 8: Allocated and realised support in different Tunisian direct support programmes

	2010		2011		2012		2013	
	Allocated (in thousand DT)	Realized (in thousand DT)	Allocated (in thousand DT)	Realized (in thousand DT)	Allocated (in thousand DT)	Realized (in thousand DT)	Allocated (in thousand DT)	Realized (in thousand DT)
PMN	55600	52625	54100	56581	46200	44245	39100	36247
Diagnostic	..	2881	..	2502	..	1877	..	2334
Mise à Niveau	..	40863	..	45220	..	35661	..	28281
ITP	..	8881	..	8859	..	6707	..	5632
PIRD	574	86	2900	127	1500	337	1500	315
PNRI	..	..	1684	449	2250	476	2700	381
FOPRODI	42000	57000	48000	48000	58000	58000	65000	55000

Source: MoI

Notes: current prices. The budget amounts allocated for the NBM represent the appropriations provided by the Ministry of Finance for the upgrading programme. The data on the budgets achieved do not relate to the funding committed, but to the funding actually granted to beneficiaries. For FOPRODI, the data do not distinguish between premiums, reimbursable endowments, and equity investments. The «carry over» of unrealised budgets is not automatic. For example, it can be done in the case of PMN and ITP and not in the case of PNRI.

Table 9: Number of approved cases in the PMN, ITP, PIRD and PNRI programmes

	2011	2012	2013	2014
PMN	348	355	384	301
ITP	567	719	722	614
PIRD	11	7	16	5
PNRI	6	7	4	5

Source: MoI, Hassan (2015).

Note: For the year 2014, only the period from January to September is covered. The number of files approved does not necessarily correspond to the number of recipient companies.

Table 10: Company awareness of various direct R&D support programmes in the Tunisian manufacturing sector

	Instruments (%)	PMN(%)	PIRD(%)	ITP(%)	PNRI(%)	RIICTIC(%)
10-249	14,1	13,5	3,1	10,1	2,9	2,3
>250	19,6	18,9	6	14	4,5	4,9
TOTAL	14,5	13,9	3,3	10,4	3,1	2,5

Source: APII, Hassan (2015).

Note: APII business file. Companies with a workforce of 10 or more. Denominator: all companies by size that correspond to the survey at the time of data extraction in September 2014.

The low number of supported R&I projects immediately suggests that there will not be any discernible impact on the overall course of R&I in Tunisia. Interestingly, the allocated resources for the innovation programmes are about four times higher than the realised funding each year (see Table 8).

The evaluation of PNRI and PIRD were rather critical concerning the overall design and implementation of these schemes (see Institut El Amouri, 2014; Hassan, 2015; Khanfir, 2015). Although the objective of the PNRI is to encourage collaboration between companies and public institutions, such as technical centres and research institutes (i.e. for knowledge exchange), the way the programmes are structured limits the potential benefits deriving from mutual learning and knowledge transfer. The central role of the technical centres in the PNRI, which gives them the exclusive right to build prototypes, restricts learning on the side of companies.

Both programmes are characterised by substantial red tape and vague application and evaluation processes that require broad and often tedious procedures to obtain data on the company's side, as well as opaque decision-making structures. Companies also complain that decisions are taken without the support of independent experts, that procedures are lengthy and financial support insufficient (Hassan, 2015).

Last but not least, the awareness for some direct financial measures in favour of R&D and industrial innovation among enterprises in the manufacturing is rather low (see Table 10). Only 14.5% of companies are aware of the most important support programmes.

3.2.4 Conclusions and recommendations

Increasing R&D spending in enterprises

- Tunisia should increase R&D and innovation spending with the specific purpose of fostering sustainable development and employment.

The broader and more appropriate target should be to support and increase innovation efforts. This will help the Tunisian economy and society to respond to the challenges ahead. The aim is not to increase R&D without limits, but to use it as efficiently and effectively as possible to address the economic and societal challenges ahead. Successful problem-solving will also increase the willingness to invest more in R&D.

The PASRI study (Hassan, 2015) suggested the adoption of a "clean slate" approach to shake up the Tunisian system before a new working "equilibrium" with visible improvements are reached. Therefore, an overhaul of the innovation system – and particularly of the **governance structure** – is a must.

Still, although fully sharing the insights of the PASRI study, we suggest only a few interventions that will help to increase innovation without changing the overall system. The core of these interventions should be developed by Tunisian stakeholders in a **public innovation process** that may be a blueprint for future reforms (i.e. innovation processes started and executed by the public sector).

How to develop or rework support measures in practice?

We suggest the development of two measures:

- The first is a simple measure that enables companies to innovate and/or perform R&D. This measure should address companies of all sizes and sectors.

- The second measure should stimulate mutually beneficial cooperation between different actors in the NIS (e.g. companies, universities, technology centres, technopoles, etc.), supporting sustainable development.

These reworked measures would complement the existing programmes that focus on technology adoption via investment. We are obviously aware that there are already measures tackling these issues. Thus, the PIRD and PNRI programmes should be overhauled using the public innovation process (e.g. lean start-up) described below rather than be accompanied by new programmes. The only objective to be achieved should be improved innovation performance that puts Tunisia on a sustainable development path in the medium and long-term future. We also recommend adding a third measure:

- An innovation voucher scheme to stimulate cooperation in the NIS and new rules at universities (see Section 3.1.3) to incentivise cooperation with companies.

An innovation voucher of 5,000 TND should be made available for business cooperative projects with universities and technology centres. This voucher

should cover half of the cost of the cooperative research project. This enables companies to get easy access to financial support for the execution of cooperative projects and thus to procure scientific and/or technological input for their activities.

In practice, applications should be done online, giving a **brief description** of the project, the company and the scientific/technical cooperation partner and the innovation activities of the companies so far. The innovation voucher should be awarded within five days of submission. After completion of the project, companies will report how the project was executed and document how resources were spent. It should not just support companies, but also allow the collection of important information about national innovation activity that can be used to design the innovation agenda.

- As proposed in Section 3.1.4, the innovation voucher must be complemented with new incentives for universities to cooperate with companies. Cooperation with companies should be considered among the criteria for career advancement in academia and universities must be able to keep and manage the resources they earn from collaboration without intermediation from the Ministry (see Section 4.4).

Although we have conservatively estimated that there are more than 200 innovating companies in Tunisia (see Appendix A), the majority of them will most likely struggle to carry out innovation projects alone or in cooperation with research institutions. Following Cirera and Maloney (2017), companies might not be equipped with the necessary management skills and organisational practices to execute innovation projects. The existing support measures for catching-up should be evaluated with respect to making companies ready for innovation. If companies do not possess these basic management skill, direct support to innovation and cooperation will either not be requested or will be consumed without creating the expected positive impacts on the medium to long-term development of Tunisia.

Reworking and designing policy measures is beset with high risks as basic data to assess R&I performance of companies is missing. Consequently:

- Methods that deal efficiently with these risks have to be used. Involving Tunisian stakeholders in the process is a further step to create measures that work as desired.

The lack of data and analyses (e.g. R&D survey, innovation surveys, evaluations, studies) necessitates that decisions on the design of policy measures are based on a process that generates and validates the data itself. In other words, this process produces data that is used to take decisions on the design of measures. We recommend the introduction of an open and participatory process. The research priority-setting process and the elaboration of the Start-up Act have already demonstrated that this is a viable approach in Tunisia. Still, a clear process design and a method to produce the required output is needed. There are two alternative ways to set up this participatory process for reworking PIRD and PNRI and designing the voucher scheme:

- The lean start-up method (Box 18) deals with the insecurity related to innovation for companies as well as for research institutions and public actors. The aim of this method is to understand what governs innovation in target groups (i.e. enterprises, research institutions, intermediary organisations).

This is achieved via interviews, surveys etc. that test hypotheses. If a hypothesis is validated, the insights are used to build the features of the intervention measures which are then again tested. The GIZ activities in Tunisia as described in Box 19 come close to this approach. Once the main features of the reworked measures are validated, the scale can be increased.

- A more traditional participatory process could also be used. In such a process all stakeholders and interested experts should be involved in three phases: firstly ideas for improvement of the measures are gathered and evaluated in a public (online or offline) brainstorming; secondly, the ideas are used to rework the programmes with the help of a group of experts; thirdly, the resulting proposals for policy intervention are discussed and validated by all stakeholders (online or offline) depending on the degree of openness chosen. The output of these three phases should be implemented, closely monitored and adapted if needed.

Big companies – SMEs – start-ups – sectors or what?

- The illustrated approach so far has not targeted any specific group. We uphold this orientation rather than focus on a particular group in advance.

There are two reasons for keeping the programmes open to all applicants: firstly, there is little information about the top innovators in Tunisia. While we estimate that there are more than 200 innovating companies (see above), at no point during the PSF country visits, did we get the impression that these companies are known to policymakers. Thus, policymakers should focus predominantly on attracting good projects irrespective of the sector or size of the company rather than having a clear focus on target sectors. Moreover, Tunisia already has several sectoral programmes and support activities. This is reflected in the activities of sectoral ministries, technopoles and clusters. A focus on existing sectors always comes with a tendency to harden existing structures rather than fostering structural change. As the latter is conducive to a more innovation-oriented economy, the measures to be developed at this point in time should not focus on specific sectors.

- A precondition for this approach is that measures should be easy to administer on the public side and accessible without serious hurdles by applicants. This should result in minimised red tape, a processing time for applications of maximum three months and a lean monitoring of projects once they are approved. The innovation vouchers should be decided – as already mentioned – within five days.

Framework conditions

We recommend planning sufficient allocation of funds for the medium-term support of private R&I expenditure, setting clear targets for the level of cooperation that needs to be achieved in the NIS, and creating annual reporting cycles that rely on real data of R&I activities. We also recommend starting broad and continued dialogue with various groups of stakeholders in the NIS and working on incentives to promote collaboration. More concretely, the increase in R&I expenditure results from projects that efficiently and effectively employ these inputs to develop high-quality products and services. We therefore abstain from setting a clear target for private R&D spending, but suggest that sufficient resources for supporting these activities should be set aside for a medium-term period. This gives credibility to the planned actions.

- Any attempt to manage the NIS or of individual measures must rely on robust data. As there is no tried and tested data on these issues, target-setting is impossible.

Producing survey-based and up-to-date figures on R&I in Tunisian companies is urgently needed. Without data it is simply not possible to identify in which direction the system is moving. Thus, a regular R&D survey and a separate innovation survey – the European Community Innovation Survey is a best practice – should be established as soon as possible. This should be complemented by an annual report on the state of development of the NIS. This is the basis for setting targets and communicating them to stakeholders.

- The MHESR should start together with the MoI and the Ministry for Information Technologies a dialogue on R&I and the intended sustainable development path with specific segments of the Tunisian business sector (large companies, start-ups, SMEs, foreign-owned companies, public companies).

These activities should include at least one big conference a year and monthly events on the issues at stake. It is important that the events stimulate dialogue and not one-way communication from the ministries to the stakeholders. Initially, 500 companies should be involved and invited to participate in this dialogue process, but it should always be open to accommodate companies that were not invited or initially involved. The number of involved companies should be increased in future years. This will help to better understand the needs and problems when performing R&I activities. At present, company representatives do not know where Tunisia is heading and what kind of support programmes are offered, and policymakers are not aware of the R&D performers in the country.

- As increased collaboration and cooperation between science and industry is an essential part of efforts to improve R&I activities, the interface on the science and research side has to be managed too. This includes all actors that are involved in technology transfer. Incentives have to be set in a way that cooperation is beneficial for all involved parties.

Start-up ecosystem

The evolution of the Tunisian start-up system largely benefited from a host of private actors from both Tunisia, the region and international donors. It is in the

interest of Tunisia to keep these actors motivated. The public sector should continue to feed the system without turning into a dominant force shaping it. Thus, further simplifications in the business environment would benefit start-ups, newly established companies and SMEs alike. The simplifications should be elaborated in a collaborative process together with the start-up community in Tunisia.

- The public sector should modernise start-up activities in its own domain. This concerns speeding up the establishment of research-based start-ups in the academic sector and the modernisation of service offerings by the large network of incubators linked to academic institutions.

Particularly, the spin-out and spin-off activity of research institutions should be modernised. Presently, it takes around three years to establish a company that was built on university research. This is because of a very detailed start-up process which does not – for an outside observer – increase the likelihood of success (rather the contrary). Therefore, regulation should be simplified to shorten the length of the start-up process to three months maximum. This should be accompanied by a modernisation of incubation services at universities and technopoles, which should provide the same quality of services as advanced private incubators.

- Prepare for a long-term commitment concerning start-up activities as returns will be uneven and difficult to predict.

- The contribution of start-ups to growing R&I activity may be limited in the short term and somewhat erratic in the medium term. In fact, start-up success is generally very uneven, as few tend to grow fast, many remain small and many may not survive at all. Thus, in the medium term, while successful start-ups may heavily contribute to structural change and enrich the Tunisian business landscape, there is no guarantee that this will happen.

- Localise start-ups in Tunisia by creating a favourable environment to scale activities while motivating them to keep their headquarters in Tunisia.

Long-term benefits of supporting start-ups can only be "harvested" if successful start-ups keep their operations in Tunisia. If start-ups move to other countries, the returns to the early-stage Tunisian support activities are "harvested" by the new host countries. To avoid this scenario, Tunisia must try to remain attractive as a business location, as suggested by the World Bank[38], and help start-ups reach scale internationally. Acceleration services are necessary but not sufficient. Attracting risk capital and procuring operators of acceleration services is needed to secure the next evolutionary step of the Tunisian ecosystem.

- Lay the foundation for an evidence-based management of the start-up ecosystem by setting up a Start-up Hub.

[38] See http://www.doingbusiness.org/en/data/exploreeconomies/tunisia

To implement such demanding policy interventions, a sound database of the actors in the ecosystem and their interaction is needed. Preferably, a private institution should be tasked to provide these statistics and to actively promote networking and interaction in the ecosystem. There are a number of "role models" for such an institution – see the Dutch Start-upDelta.[39]

Box 18: Lean start-up but also behavioural economics and design thinking

A method developed for start-ups should be used to deal with the inherent risks and uncertainties of creating new support policy measures in Tunisia: lean start-up or lean innovation. This approach suggests the development of hypotheses that are then tested and, once validated, implemented in policy interventions. In essence, it is a purely data-driven process that deals efficiently with uncertainties and tries to find solutions that work with as little resources as possible (see Box 1).

Applying methods that are used by start-ups might be far-fetched for policymakers as they may be unaware that they share some of the challenges with start-ups. While employing experts is often the strategy of choice to deal with inherent uncertainties, there is limited evidence that this mitigates risks that concern the behaviour/reactions of target groups. Frequently, there are highly aggregated insights about the likely behaviour of the target group, that might depart considerably from the reactions of potentially innovative or R&D-performing companies to concrete "stimuli" in the form of a support programme.

Likewise, the supply side – the working of the public administration or the agency administrating the programme – is also under-researched. Many established programmes perform on paper, but in reality they are held back by tedious procedures, are underfunded and/or are designed to cater for the risk-averse attitudes of public-sector decision-makers, rather than the needs of the target group. The lean innovation approach thus puts R&I activities in companies on centre stage and tackles uncertainties on both the demand and supply side.

The lean start-up approach (see: Blank and Dorf, 2012; Maurya, 2012; Ries, 2010) helps to develop products and services quickly and to minimise costs and risks. To this end, hypotheses are formed from the outset and tested using various methods (e.g. interviews, surveys). Only if the test is positive – i.e. market validation – the process is continued. A first milestone is reached when the minimum viable product (MVP) market fit is reached, i.e. when demand in a sufficiently large market segment can be satisfied so that the further development and marketing costs can be passed on.[40]

Innovation processes using the lean start-up method are significantly faster and more efficient than traditional approaches and work for start-ups, established companies as well as in public administration. Lean start-up requires an opening of the innovation process: customers, experts and the own employees are integral parts of the

[39] https://www.start-updelta.org. For more on such connecting hubs see the PSF report on the Slovak start-up ecosystem (European Commission, 2017).

[40] For a primer on lean start-up see here: http://theleanstart-up.com/principles

innovation team. The approach is therefore compatible with Open Innovation methods.

There are overlaps between lean start-up, design thinking, and behavioural economics. The latter analyses real decision-making processes and does not rely on the assumptions of behaviour and rationality used in economic theories and models. In many cases, human behaviour is "irrational but predictable" as Ariely (2010) puts it in a nutshell. The insights of behavioural economics are applied in such a way that desired behaviour is achieved with fewer frictional losses ("nudging"). Design thinking focuses also on the needs of future customers when developing new products and services rather than on historical data or instinct or untested hypothesis.

Source: Expert panel analysis (2018)

Box 19: How GIZ develops scalable insights for UI collaboration in Tunisia

The most important challenge for those that design the programmes is to understand how R&I decisions are taken in companies, what obstacles are to be mastered and which framework conditions are hampering or promoting this process. The only way to find out is to talk to all actors concerned. Starting with companies and then working through the system. Likewise, a better understanding why the current programmes are designed the way they are is also needed to find solutions that avoid the issues that were mentioned in the evaluation of PIRD and PNRI. Thus, the same exercise is to be carried out in the institutions responsible for the administration of support programmes in order to establish structures that efficiently design and manage support activities.

There is already a best practice example in Tunisia that illustrates how such an approach might work. The GIZ – the German development agency – has initiated about 20 collaborative research projects between companies and scientific institutions by simply talking to companies, assessing their research and innovation needs, finding appropriate cooperation partners in science, coaching them and guiding partners through the project, i.e. sorting out intellectual property issues, mediating when conflicts arose by finding solutions that work for both sides. While this was a push activity at the beginning, GIZ is now approached by companies that ask for support in setting up collaborative development processes. Properly managing such processes creates a huge win/win situation that helps companies to find solutions to their problems and provides additional resources and interesting research questions/projects for academia and research institutes. After carry out about 20 processes, it would be a good time to take the learnings and use them to scale up the promotion activities, i.e. set up a proper promotion scheme.

In order to develop such a cooperation/collaboration programme the experiences of GIZ, other innovation experts, other countries, etc. help to formulate hypotheses and speed up the development process. However, they are no substitute for "going out of the building" – to use a lean start-up catch phrase – and testing hypotheses on the actors populating the innovation system. The same applies for the programme that intends to foster innovation activities and R&D-performing skills in companies. The

insights generated by GIZ would be a good starting base for designing a measure that is to be scaled up.

One of the main advantages of the lean innovation approach is the ex-ante validation of hypotheses, i.e. of the main features of the measure. Traditionally, most measures are developed based on untested hypotheses. This ignores the fact that specific details might be decisive for success, but their impact is not known and cannot be guessed by experts before a validation exercise has taken place. Thus, if it comes to actual programme design, a more agnostic approach that relies on testing and not on expert advice is warranted.

Source: Expert panel analysis (2018)

4 R&I GOVERNANCE ISSUES

Chapters 2 and 3 addressed the research questions of this PSF, namely: (1) the revision of the research priority setting and implementation process; and (2) the valorisation of research results by creating stronger public-private cooperation. In these chapters we identified the biggest issues with the Tunisian R&I system and offered detailed policy recommendations to Tunisian stakeholders to achieve the goals of this PSF.

The two country visits also evidenced that while Tunisia is going through a gradual process of R&I system reform, there are some factors at the governance level that partly hamper the country's ability to face the two aforementioned challenges, curbing the impact of policy initiatives and their adaptability to all stakeholders. Therefore, while it is not in the mission of this PSF to address these governance issues, for the purpose of completeness and given their relevance to the topics discussed in this report, they are summarised in the following sections.

4.1 The national research effort and its long-term sustainability

The Tunisian government has recently made big steps in order to increase the country's research and innovation efforts. R&I is becoming a priority area in government policy and Tunisian research efforts are higher than in other African countries. However, the Tunisian R&I performance relies on highly volatile research budgets, partly because of the unstable political and economic situation. Research activities have recently suffered because local stakeholders, such as universities and research laboratories, have problems in planning their research activities as they fear budget cuts. Some of the Tunisian R&I programmes are not fully sustainable, or at least not on a continuous basis. Researchers cannot build ambitious thee-to-five-year research projects, nor establish collaboration agreements with companies or foreign partners without sufficient certainty about their resources or about the programmes to which they could apply in the near future. Moreover, while university attendance is free, only the top academic institutions are able to attract international students that pay fees that can be reinvested in academic activities.

The major beneficiary of the research budget is the MHESR (Table 11), followed by the Ministry of Agriculture and the Ministry of Health (approx. 12% each). The PSF team did not obtain the overall figures of public research funding. The current situation requires some efforts in sharing long-term research objectives among ministries and in providing longer-term funding to research performers. It would be advisable to prepare and circulate a **consolidated budget presentation for R&I activities including figures for each ministry**. The preparation of this document could provide a platform for institutionalising the discussion between ministries about their research strategies and expenses, greatly enhancing the inter-ministerial coordination and helping to identify redundancies and gaps. This public document should be organised around the national research priorities to help follow up the implementation of the future national R&I strategy.

Table 11 : Distribution of public research funding among Tunisian ministries

Beneficiary Ministries	%
MHESR	67
Agriculture	12
Health	12.5
Other departments	8.5
Total	**100**

Source: MHESR

4.2 Introduction of an inter-ministerial coordination system

Tunisia lacks horizontal coordination in the governance of its research and innovation system.

A frequent criticism in the past was that the country's dual structure in R&I policy, whose competence is largely concentrated in the MHESR and the MoI, and the lack of coordination between the two ministries has hampered the implementation of a coherent and systemic approach to R&I policymaking. There is some overlap between the responsibilities and missions of the two main ministries and their respective implementation agencies (ANPR and APII). The two ministries also look after different parts (agents) of the innovation system or stages of the science-to-market innovation process, leaving little space for major joint initiatives. While some progress has been recently made, according to several stakeholders the two ministries do not communicate much with each other and there is little coordination of key functions at the ministry as well as at the agency levels (e.g. the MoI is currently working with the EBRD, without involving the MHESR). **Most ministries should be involved in R&I activities, resources and policies.** In this respect, even the PASRI report (Hassan, 2015), pointed out how since the 1960s there has been a top-down culture of work carried out by each ministry. This work method raises several concerns in terms of strategy as many ministerial decisions can be conflicting with those of other ministries and the State budget may not be able to support divergent strategies.

In an attempt to improve the situation, the MHESR started collaborating with some other ministries, such as the Ministry of Health and Agriculture, in the management of specific common research programmes, research centres and technopoles, and in the promotion of research networks. A step forward in the management of institutions and in the definition of a common scientific strategy has also been made by inviting other ministries to help define the National Research Strategy. However, the inter-ministerial collaboration is still based on spot initiatives and on the commitment of some ministerial delegates who influence the success of these collaborations. Some ministries create their own research strategy, without any coordination with the existing National Research Strategy, and the future national quinquennial (five-year) plan is prepared at the

inter-ministerial level without much information on how it will be articulated with the already-existing national strategies. Moreover, the MHESR and the MoI still seem relatively far apart in the decisions about the management of the technopoles and innovation programmes.

Therefore, Tunisia needs an institutionalised system of cooperation between ministries. The past bodies acted more as a "scientific advisory committee" to the minister than an administrative inter-ministerial committee. Coordination of public research policies could be done at two levels, to ensure the consideration of all the management and policy issues between the ministries.

First, the MHESR could initiate **regular and formal bilateral meetings with delegates from all other ministries involved in research activities twice a year**. This could be the opportunity to discuss the elaboration of the budget, the difficulties of implementing the National Research Strategy, the ongoing reforms in the area of HE and R&I activities, and of coordinating the management of research centres and technopoles. This is mainly an opportunity to create working relationships and practices between the services.

Secondly, **an inter-ministerial committee at the DG level could discuss the strategy and coordination of the policy mix for HE and R&I**. This could be chaired by the *Présidence du Gouvernement* to ensure a good level of participation and that there will be no tension between ministries. Each DG could name a 'sherpa' in charge of the follow-up of the research activities to prepare each meeting. This 'sherpa' could assist the committee but should not replace the DG. This inter-ministerial committee would be in charge of formulating and validating the methodology and tools to define the research priorities of the National Research Strategy, to follow up their implementation, to organise its evaluation, but also to transmit those priorities to the political level for further validation. This committee should also discuss the articulation between sectorial research strategies and the national one, about a common Tunisian international scientific strategy and about future policies affecting all research activities (e.g. the status of researchers, the evaluation of researchers methodology and criteria, the organisation of an inter-ministerial funding agency for competitive research projects, intellectual property, the impact of Open Science on research production, publication, and valorisation, the preparation of the Tunisian participation in the future Horizon Europe). Therefore, **this inter-ministerial committee will not be an advisory body to the Government but an administrative body promoting coordination of the various public policies and the coherence of the R&I policy mix.**

The aforementioned preparatory body could be tasked to discuss and comment on the state-of-the-art in its fields. The main inter-ministerial research funding institutions, the research evaluation agency, the "platforms of research institutions" working on each societal challeng, the networks of incubators and of technology transfer platforms and UTICA could be invited to join the inter-ministerial committee for that purpose. This way, major stakeholders can be involved in this discussion (especially combining both research capacity and industrial needs viewpoints), and the discussion at the inter-ministerial committee would be better prepared, especially with respect to budgetary discussions related to the allocation of funds to specific research priorities.

The Tunisian Parliament is not yet involved in R&I policies, except the yearly discussion on the State budget. Universities and research centres have had little opportunity to present their needs to Members of Parliament. There is no space for democratic debate about the needs of citizens and society concerning higher education, research and innovation. In almost all democracies, the Parliament has the power of evaluating and controlling the decisions of the Government. The national research priorities and their implementation, as one of the main national policies, should always be evaluated by a legitimate body. A specific **commission of Parliament's members dedicated to HE and R&I** would have the legitimacy and skills for such evaluations. It could also review how new knowledge and technologies impact on current and future laws. To create such a Parliamentary Commission, Tunisian authorities could do a benchmarking with the Science and Technology Options Assessment (STOA) committee of the European Parliament, and with the European Parliamentary Technology Assessment Association (EPTA), a grouping this similar commissions dedicated to science and technology across national parliaments in Europe.

4.3 Clarification of the rules and relationships between stakeholders

Concrete strategic reforms are taking place in Tunisian R&I policy. The recent elaboration of a National Research Strategy (supported by a wide consultation process) and the creation of a new status for HE and research institutions (EPST) with increased autonomy are some examples of these concrete reforms. But more work is needed to achieve it.

The ministries still carry out different functions and activities while they should focus on their core functions. Typically, the three functions of a ministry of research (scientific orientation, programming and evaluation) are not yet distinguished and are still mixed with the management and control of the activities of the institutions. The current National Committee for the Evaluation of Scientific Research Activities (CNEARS) still depends on the MHESR and is not an independent agency as in some other countries. In this respect, the recommendations of the PASRI report (Hassan, 2015) have not yet been fully implemented. There are no websites where transparent evaluations are published. Moreover, while a self-evaluation form for university laboratories is available, the criteria on the basis of which the evaluation is done are not public.

At the government level, the ministries centralise many functions, some of which have no strategic value (i.e. administration and approval of how academic funding is spent), leading to rigid controls over the activities of researchers and research institutions. Universities have no autonomy to spend their budget as deemed necessary, including buying equipment and hiring employees. Academics have problems spending funds, since they need to undergo several long administrative control procedures and/or obtain authorisations from the MHESR as well as from the MoF. The MHESR is in charge of validating all expenses of public HE and R&I institutions, while the *Corps de controleurs* from the MoF reduce considerably the spending autonomy of institutions.

There are more than 600 laboratories and research units. The ministries cannot adequately negotiate, evaluate and control all scientific projects and priorities for

these labs. The ministries need to **delegate lab coordination and supervision to universities** and then assess their performance in teaching, research and third-mission activities. At the moment laboratories receive their funding directly from the ministries and their expenses are directly managed and validated by them. The recruitment, salaries and even the expenses for new buildings are approved directly by the ministries. More autonomy should be granted.

Research institutions crave **leaner administrative processes** as they believe that their research performance and third-mission activities are both hampered by this lack of freedom. In fact, researchers cannot choose which scientific materials to buy and use, even when they are co-funded by a company or part of an international research project (e.g. Horizon 2020). They cannot manage the research funding they earn, appointing, for example, a short-term research officer to help with the project work. Every expense needs to be signed by the 'director of establishment' and this, in their view, is highly de-motivating. The public-market operating rules apply even if the resources are not publicly subsidised. Even the university rectors or the directors of research centres and technopoles have to be authorised by the MHESR one month in advance to travel to meet research partners. These are only some examples of the ministries' hold over the researchers and the red-tape hampering their work.

More autonomy and responsibility should be given to universities, research centres and technopoles. After the negotiation and definition of clear, long-term missions and objectives (3-5 years), the management of an institution and of its labs and research units should be carried out directly by the institution itself. This autonomy could apply to different areas: finance, expenses, recruitment, careers, salaries, working conditions, buildings, own scientific priorities, services organisation, etc. An ex-post government evaluation could assess financial aspects as well as management. The same ex-post evaluation would apply to the objectives (e.g. in the area of research performance), with consequences on the director's career, on recurrent funding for the institution and on reorientation of its activities.

The recent creation of a new status for institutions illustrates the will of Tunisian authorities to devolve functions to lower levels of the innovation system. Institutions with an EPST status benefit from more autonomy than other institutions, but the conditions for an institution to be eligible for this new status are hard to meet. An increasing number of universities (e.g. university El Manar) have applied in recent years for this EPST status leading to leaner management of finances, but they can wait for years for the status to be granted. There is agreement in large Tunisian academic institutions that strategic directions can only be implemented and managed well if more autonomy is granted, allowing more freedom in the hiring of technical staff, administrative staff, short-term contract researchers, and in building policies and maintenance.

To make this autonomy trend acceptable, the ministries should develop the **framework of wardship tools** to create trust. A performance contract or wardship convention has to be negotiated and signed by both the institution and the ministries involved. This contains a reminder of the missions of the institution, the objectives of the institution (both on training and research priorities and production, but also on structural organisation), details about its main activities,

resources and trends, as well as quantitative and qualitative indicators for evidence-based follow-up and ex-post evaluation of the implementation of these objectives. Upon recruitment, a new rector or director should receive a "mission letter" explaining exactly what is expected by the ministries from this new chief to implement the objectives of the institution written into the performance contract, the structural changes needed in the institution and the main political orientations of the ministries. Indicators should be linked to the targets set by ministries. This would guide the main orientation of her/his action. Directors should be assessed on a yearly basis. A part of the salary of the director could be linked to the achievement of those targets, as a bonus. Those three wardship tools (performance contract, mission letter and yearly target letter to the director) should be developed for all autonomous institutions. They could be proposed to all public HE, R&I institutions as a step forward to increase autonomy. This increase in autonomy is necessary both to implement the scientific priorities and to develop academic-private collaboration.

Universities and research centres should be made accountable for their strategies. They should be able to recruit staff according to the criteria set by the MHESR (i.e. the number and size of salaries that the government can afford to pay to staff each year) and carry out daily management of the laboratories. They should also be able to steer the research specialisation of the laboratories, promoting mergers and growth of the most valued or "virtuous" labs on the basis of the criteria set by the MHESR (i.e. research productivity, priorities, third mission, international collaborations, interdisciplinarity, etc.).

4.4 Rationalisation of the HE and R&I system

In the last two decades, the Tunisian innovation system has been growing in terms of size, complexity and number of actors. The country has many research centres and HE institutions, some of which perform good research and have a wide network of innovation intermediaries (e.g. technopoles, clusters, TTOs, incubators, etc.). However, the system is fragmented and lacks effective governance. The missions and functions of the actors located at different levels in the governance structure are not clear. Moreover, the lower levels of the NIS do not have sufficient financial and decision-making **autonomy** and competence, nor awareness of the need to define priorities. A few notable exceptions (e.g. IRESA) exist.

During the PSF country visits, direct beneficiaries (public researchers and private companies) confirmed that it is hard to identify who could support them in knowledge transfer activities, and different actors have different reference points for the same kind of services. Therefore, the central government should put more effort into coordinating and rationalising the system, increasing the critical mass of individual actors and introducing clearer long-term specific objectives and competencies. This also emphasises professionalisation and skills improvement.

While some of the recent Tunisian initiatives to support knowledge transfer are inspired by initiatives implemented in France (e.g. the technopoles), there are some doubts about the transferability of the French experience with innovation policy to Tunisia because of the very different economic structure, size and

competitive context, innovation culture and availability of resources. While there is little evidence on the performance of individual actors of the system, it is evident that at **present the fragmentation of the national system makes the implementation of efficient R&I policy hard. Competencies are scattered in the system, the functions of different actors are not clear (even to stakeholders like academics) and there are questions about the governance of the whole innovation system in the long run**.

4.4.1 Universities and research laboratories

Tunisian universities are small in size and high in number. The identified teaching brands are still *établissements* (internal schools and faculties). The HE system is an asset for the country as it makes the Tunisian population one of the most educated in the whole of Africa, with a relatively low level of gender or social bias in access to HE. However, as noted above, they lack sufficient financial and decision-making **autonomy**. The high number of Tunisian HE institutions causes fragmentation in financial and administrative resources, as well as problems in knowledge management which tend to add to administration costs. This system is obviously expensive to manage and not efficient in terms of job placement for graduates. The current situation of the HE system is a major obstacle to the optimisation of public research funding, to the establishment of interactions between stakeholders and therefore to the ability of the Tunisian research system to address the main societal challenges. Current economic conditions and levels of efficiency limit the HE and R&I system. Moreover, the scientific specialisation of the national research system is low, despite the small size of the country.

Academic institutions host many small research laboratories and units. The labs are relatively small in terms of personnel (10-20 staff) and carry out research activity with little supervision by parent academic institutions and by the MHESR. The evaluation of Tunisian academic institutions is also done at the lab level rather than on the institutional level. The reasons behind the relevance of laboratories in the Tunisian academic system is linked to the prevalence of a 'bottom-up' approach in research funding. Essentially, researchers choose research topics and the MHESR funds bottom-up research projects. To benefit from easier access to funding, researchers are pushed to create small labs, which are research teams with homogeneous research interests.

This approach to research funding has limited effectiveness in terms of R&I policy because, while the researchers have relatively high academic freedom, there is no steering activity, interdisciplinarity or alignment with national priorities. This also makes it difficult to align the scientific activity of laboratories with national and local priorities from a smart specialisation viewpoint. Moreover, the establishment of labs is not decided on a scientific policy basis by the local universities involved, but by the ministry based on an administrative process.

In this situation it is obviously difficult to supervise the activities of laboratories and monitor their efficiency (e.g. objectives, performance indicators and ex-post annual reporting). Moreover, given their limited size, they struggle with research management activities (e.g. burdensome administrative tasks), which also affect researcher productivity.

Overall, there is a clear cultural conflict between a bottom-up approach to research funding, which sponsors lab efforts and ideas, and a more systemic, strategic view of research, governed at the university level, which would be in line with the approach used in other research-intensive countries.

There is a clear lack of critical mass at both the university level and at the level of the labs, which is due to the fragmented academic system and institutions' limited autonomy, as mentioned elsewhere in this report.

As research activities are more efficiently performed when resources and especially competences are concentrated, it is necessary to foster project-based collaboration across Tunisian institutions to boost critical mass and rationalise the system of **laboratories**. Therefore, the MHESR should incentivise universities and promote mergers between laboratories. The rationalisation of the number of laboratories and research units should be based on a scientific basis, looking after potential complementarities and collaborations. Laboratories should have at least 50 FTE researchers, with people working on different projects in different "research teams" with their own research specialisation but sharing administrative and technical support staff, equipment and competencies. While labs usually work better if researchers share the same working space, labs could also be shared across several research institutions, involving researchers with similar research interests (e.g. acoustics, packaging, etc.). Mergers can be either forced (with public money available only to larger entities) or incentivised (mergers get access to additional money). A research system based on fewer units would ease data collection and the monitoring of research activities, the definition of long-term strategies and industry collaboration. The merging process should not limit the possibility to create new labs, but their creations should be based on grounded scientific and strategic reasons like their focus on emerging interdisciplinary subjects or new scientific fields. International or public-private research collaborations could be good reasons to create new labs. The conditions for lab creation could be changed in order to emphasise research duties, but this would be meaningful for researchers only if it goes into a complete revision of what a laboratory is, its governance and funding process, its relationship with the ministries, parent universities and research centres, on how labs comply with university and national research strategies.

The MHESR should take the lead in this merging process. Once the rule-of-thumb for the size of labs is set at 50 FTE researchers, academic institutions should be invited to progressively merge laboratories within a given timeframe (e.g. two years). The MHESR should take this opportunity to align the specialisation of labs with the national strategy providing additional funding to projects in priority areas, especially if carried out in collaboration with laboratories located in other universities. The MHESR should make universities accountable and responsible for the management of the research funding distributed to labs. This is necessary to foster the development of research strategies rather than stand-alone research projects.

4.4.2 TTOs

Tunisian universities and research centres engage with industry at very different levels of intensity. This is acceptable, given their different scientific specialisation, geographical location and size. However, they also differ in terms of access to intermediaries such as TTOs. In other words, while some universities have made efforts to create an environment which favours collaborations, technology transfer and entrepreneurship, others have not taken such steps. In Tunisia, the management of IP was entrusted to TTOs in 2012 by the ANPR. This initiative has not yet delivered the expected success because TTOs are not sufficiently connected to markets and because of limited resources allocated to them (Khanfir, 2015). Tunisian TTOs support the exploitation of research results and the creation of partnerships between technology suppliers and users, but while there are no exact figures on their capacity, stakeholders agree that, in their words, they are "empty shells", as the majority of TTOs employ not more than two people. Those people are not always full time and may not have business experience nor the necessary skills for the job. The ability of universities to identify and hire candidates with previous private-sector experience, or to train them to perform this special activity (possibly using costly external companies), has a direct impact on their future autonomy.

The impact of TTOs on innovation performance is debated in the literature (Box 20). While the experience of industrialised countries shows that their contribution to licencing and technology transfer as a whole is often very limited, there are some factors that increase the probability of success. For example, Conti and Gaule (2011) find that TTOs' performance in terms of licencing is driven by TTO size (number of staff), age, and availability of a TTO director with a business background. In the case of Tunisia, the impact on the national innovation activity is still unknown. The lack of resources is a chronic issue and several actors in the innovation system (universities, technical centres, business incubators, research centres) agree that, as things stand, TTOs represent just another 'layer' of institutions in the innovation system with no impact at all on technology transfer.

Therefore, as TTO creation is a recent initiative for Tunisia, efforts are needed to integrate the activities of these offices into academic institutions and establish effective procedures to support transfer and evaluate the effective contribution of these intermediaries to technology transfer. There are at least two basic approaches that Tunisia could adopt in rationalising the TTO system: (1) continue to develop TTOs as university/research centre resources to promote and facilitate industry-academia collaboration; (2) aim for self-sustained, business-oriented independent TTOs, which sell their services to universities, research centres or any other entity (e.g. technopoles, clusters, etc.) seeking to facilitate and/or benefit from industry-academia collaboration and/or commercialisation of research results. While there are arguments that can support both approaches, the latter is perhaps too distant from the current situation, while the former may be more appropriate at this stage. However, even the former can include features of the latter, most importantly organising the funding for TTOs so that it is quality, success and demand based (e.g. vouchers for researchers and companies to use TTO services instead of money directly allocated to the TTOs).

One preliminary recommendation is, **once more autonomy is granted to academic institutions,** they should be encouraged to establish a technology transfer strategy, which features academic entrepreneurship (i.e. via start-ups/spin-offs), licencing and collaborative projects with companies. The responsibility for the strategy and its monitoring would be at the university/research centre, thus forcing them to recognise technology transfer activities in their mandate. Academic strategies should also consider making use of university services such as those provided by TTOs. The strategy should highlight realistic objectives as well as the earning logics (i.e. how the TTO intends to become gradually self-sufficient and/or increase research commercialisation). Academic policies should emphasise a funding model based on the quality of TTO services (e.g. using a voucher model, where the funding is attributed to the researcher/company), their success (e.g. size and number of collaborations with companies, size and number of start-ups/spin-offs) and demand for services (e.g. voucher-type models, where if the demand is low, there are fewer paying clients and less money for the TTO).

While TTOs' inefficiencies are not likely to represent a barrier to interactions, it is necessary to clarify the role of these offices in the innovation process in order to improve the chances of success of this initiative. At present, TTOs do not have a clear mission, and if they do, it must be aligned to those of hosting institutions in order to better identify competencies and responsibilities of actors involved in the innovation process. In other words, notwithstanding the effective endowment of financial and human resources, access to 'good' inventions and researchers in hosting institutions and the availability of competent management with a business background, it is necessary to determine whether TTOs have the same mission (e.g. maximise university licencing) and if this mission is aligned to the objectives of hosting institutions such as universities or technopoles. A national process led by the MHESR (and eventually the MoI) should clarify the mandate/role/mission of the TTOs in collaboration with the universities and research centres. This process should **establish a permanent platform for the TTOs**, where they could develop joint practices, tools, collaboration models, signposting arrangements, etc. and learn from each other and from international good practices. This would also allow them to access each other's external expert networks, thus allowing them to quickly identify the optimal expertise across the whole network.

Box 20: The role of TTOs in innovation systems

The role of TTOs is to set up a structured process of IP management in support to the technology transfer between universities and businesses and many research institutions around the world have established these offices in order to encourage scientists to consider commercialisation and to support them through the process (O'Gorman et al., 2008). However, while the experience of some industrialised countries has inspired the creation of TTOs around the world, the role of these offices in developing countries is very different from the role they play in developed economies, where it is broader and includes creating entrepreneurship culture at university, facilitating of UI collaborations, research contracts between scientists and research visits, supporting academic entrepreneurship and knowledge commercialisation (Grimaldi et al. 2011). Moreover, there is mixed international evidence regarding the effective impact of these offices on knowledge transfer and UI interaction. Several studies focus on understanding the relative performance of TTOs (Chapple et al., 2005), their impact on the creation of spin-off companies (Lockett and Wright, 2005) and their potential role in second-order spin-off activities (Leitch and Harrison, 2005). The results of these studies indicate that in the UK case, TTOs show low levels of efficiency, very heterogeneous performance, and decreasing returns to scale. Siegel et al. (2007) show that the involvement of a TTO can slow the commercialisation process because of the greater concern with safeguarding researchers' interests and maximising university returns. Some perverse effects of the policies adopted by TTO managers in the US are highlighted in Litan et al. (2008), which finds that TTO frequently become bottlenecks to, rather than facilitators of, innovation dissemination. Litan et al. stress that implementation of what they define as the "revenue maximisation model of technology transfer", inhibits the dissemination of innovation and rewards the university TTO on the basis of the revenue generated rather than the number of inventions that the university transfers to industry. In the case of Italy, Muscio (2010) finds that the establishment of a TTO does not increase the frequency of university-industry interaction; however, he finds that better managed TTO and greater use of their services by university departments positively affect the probability of the TTO being involved in university-industry collaboration. The author also finds that academics rarely prefer to involve a TTO in their collaboration agreements, preferring to deal with businesses directly. Coupé (2003) provides evidence that US universities with a TTO increased their patenting activity compared to those with no TTO. Chukumba and Jensen (2005) demonstrate that the older the TTO the higher is its performance.

4.4.3 Technopoles

The Tunisian technopole system is quite complex. Supporting Youssef et al. (2013), the parks are probably too many for a small developing country like Tunisia and they have very different levels of maturity. At least when compared to European countries like France, the Tunisian technopoles are also quite small (60 hectares vs. the average 2,000 hectares in France). Their main feature is to offer cheap 'real-estate' to research facilities and companies, favouring the territorial aggregation of research performers in given scientific and industrial domains. From the outside, it is evident that some of them have a good fit with the local industry and good collaboration potential, hosting companies in their premises, while others do not. Each pole has an administration council with decision-making power, but their mission is defined by ministries (primarily the MHESR and MoI).

The organisation of technopoles varies widely and so does their mission. Some of them involve large companies, others do not. Not all of them host incubators and TTOs, questioning the governance of these intermediaries (i.e. their primary focus in terms of sectors and their reference stakeholders).

Tunisian technopoles are inspired by the French model of parks and do not consider other designs that are emerging around the world, in particular the British model of science parks, which is based on very tight linkages with parent academic institutions excelling scientifically in particular fields. The Tunisian model leans towards the model of technology clusters, in some cases adopting a research-led approach, as in the case of Sidi Thabet, and in other cases a demand-pull approach, such as the Sousse technopole, providing to companies the services of research institutions, technical centres, TTOs or incubators. In some cases, they act like regional development agencies.

There are some doubts about the critical mass of demand for these services. While Tunisia seems to generalise the technopole model to many areas and products, the international experience suggests that only in a handful of cases these parks can be considered successful, especially if the metrics are considered (e.g. what can be considered as good performance in the textile sector is not what decrees success in the biotech sector). Moreover, as stated above, there seem to be too many poles for a country with the economic structure and the research infrastructure of Tunisia.[41]

[41] While every national system has its own specificities, which make comparisons tricky, some references can help to define the scale of the Tunisian technopole system. For example, despite being considered a moderate innovator by the European Innovation Scoreboard 2017, Italy is the country with a similar economic structure to Tunisia, with the largest part of the economy represented by micro-enterprises, and a technopole system with a mixed-model strategy. While it is not easy to distinguish between Italy's service centres, technology districts, science parks, and therefore identify the exact number of parks that are comparable to the Tunisian system, the most optimistic estimation of Italian parks identifies only 34 in total, while there are 11 parks in Tunisia. This means that, despite the overwhelming availability of support institutions (TTOs, incubators, service centres) in both countries, there is one park per million people in Tunisia, which is more than double that in Italy. Moreover, there is an issue of self-sustainability. Intesa-Sanpaolo (2018) monitors the level of performance of some of these parks in Italy and the latest

Finally, while the government and stakeholders put much hope in the Tunisian technopole system, there are no evident links between the country's research priorities and the technopoles' specialisation. The top-down prioritisation in the choice of sectoral specialisation of technopoles has happened at the level of ministries when integrating their strategies and the governance model seems to depend on decisions by the technopoles' boards of directors. In some cases, technopoles are driven by a top-down approach, facilitating science-based innovation activity. In other cases, they are more familiar with a bottom-up approach, trying to respond to the needs of the local industry.[42] These concerns are supported by Youssef et al. (2013), who argue that the choice of technopole creation was based on political considerations rather than on knowledge of specific sectors.[43]

Technopoles are governed by several ministries and were funded by the CDC. While a joint governance system of the Tunisian ministries would be beneficial in harmonising the mission of these intermediaries and their organisation, overall, for technopoles to be successful, the role of the private sector and research centres should increase and the role of government should be limited to that of an enabler, supporting the creation of innovation-friendly ecosystems, in a triple-helix approach (Etzkowitz and Leydesdorff, 2000).

From the outside, it is not clear at the moment the role that technopoles could play in the Tunisian R&I system, hence a clearer definition of their mission and their model are needed (i.e. Are they pursuing a technology-push approach? Are they regional development agencies? Are they geographical spaces gathering competencies and services?). At the same time, allowing sufficient levels of flexibility and adaptability should be granted, which would allow them to better operate in their respective contexts (technologies, industry structures, market trends, etc.). Technopoles should have sufficient autonomy and independence, while being closely monitored for their impact. The funding model should also emphasise the increasing role of companies (companies should cover increasing amount of the costs of technopoles, which can take many forms such as membership fees, fees paid for using technopole services, participation in technopole/joint investments e.g. in research and/or innovation infrastructures such as experimental and pilot facilities, etc.). In fact, channelling public funding to technopoles through companies (e.g. using voucher-type models, or allowing companies to deduct all payments to technopoles in their taxes, etc.) forces/incentivises companies to take a more active role in developing technopoles and their services. Direct grants or soft loans could be made available to technopoles for developing shared larger-scale experimental facilities and

report shows that only 17 out of 22 parks had positive balance sheets in 2017, despite generous government contribution.

[42] On the map provided by the MHESR, the blue ones are directly connected to/managed by the technical centres, financed by MoI.

[43] The authors mention the examples of the ICT and Multimedia park set up in Sfax. While the El Ghazala technopole is working well, as too Sfax, which is hosting the best research centres in the country and probably in Africa in biotechnology, another Biotechnology park was set up in Sidi Thabet where there is no relevant industry.

platforms (e.g. a flexible pilot facility for experimenting with different manufacturing methods or materials, virtual ICT application environments to develop and test new applications in real-life simulations, etc.).

Self-sustainability should definitely be the long-term objective, but this is not viable or realistic in the short term. However, the funding model can play a major role in speeding up the development of a professional management culture and funding system, which are essential for managing self-sustainable operations. Even if significant funding still comes from the government, it should be competitive (not automatic) and/or based on service contracts (performance contracts). This would help technopoles to develop a more commercial and service-oriented business culture, which must rely strongly on the needs of their target audience, namely companies they intend to provide services/added-value to.

Finally, at the moment the specialisation of technopoles does not consider the nascent national R&I strategy. While the MHESR is pushing for research specialisation in key priority areas, these areas are not accounted for in the specialisation and services of technopoles. **Future developments of the R&I strategy should highlight how these poles should contribute to the specialisation of the Tunisian R&I system.**

5 POLICY CONCLUSIONS

This chapter summarises the recommendations presented in this report. There are a number of reforms and initiatives that Tunisia should implement in order to achieve the ambitious goals that the PSF team was asked to address. While some reforms are substantial and can only be implemented in the long term, others can be dealt with immediately. The PSF team of experts believes that there are a number of transversal issues presented here that, if addressed, should help in setting the basis for improving and growing Tunisia's R&I system. While Chapters 2, 3 and 4 focused on specific issues, here we highlight under key headings all the transversal issues that, if addressed, could help to better define research priorities, boost business expenditure on R&D, and companies' interaction with the research system. The PSF team finds that these issues can be grouped into three fundamental areas (also summarised at the beginning of the report, in Table 1).

5.1 Framework conditions

5.1.1 National R&I strategy

Extend the scope of the national R&I strategy beyond R&D policy

R&D funding should foster sustainable development and generate employment. The effects of R&D support overlap with those of innovation support initiatives that demand – depending on the sector and the company strategy and ability – large or small or no R&D inputs at all for the development of innovations. Thus, besides supporting the research system, the broader and more appropriate target of R&D policy should be to increase support to business innovation that helps the Tunisian economy and society to respond to the challenges ahead via R&D activity.

5.1.2 Exchange and coordination of strategy and policy at all levels

Introduce an inter-ministerial coordination system

There is no single overall national R&I strategy. Coordination between ministries is improving, but there are challenges related to 'horizontal coordination' and 'vertical coordination' between different types of actors (e.g. between ministries and research institutions). The lack of coordination between the MHESR and the MoI has hampered implementation of a coherent and systemic approach to R&I policymaking. There is some overlap between the responsibilities and missions of the two main ministries and their respective implementation agencies (ANPR and APII).

There have been some recent efforts in defining research priorities from a top-down perspective, but these are too broad (they are more sectors than research priorities or key enabling technologies, e.g. water) and are not applied to the different levels of the system (e.g. the technopole system is not specialised in these priorities). There are some bottom-up efforts in identifying scientific goals (e.g. IRESA). However, these priorities and methodologies are not shared.

Tunisia needs an institutionalised 'cooperation space' between ministries. The MHESR should initiate regular and formal bilateral meetings with delegates from all other ministries involved in research activities twice a year. An inter-ministerial committee at the DG level should set the strategy and coordination of the policy mix for HE and R&I.

Raise the national research priorities to an inter-ministerial level

National research priorities should be defined and coordinated at the inter-ministerial level and inscribed in the national five-year plan. An inter-ministerial committee should be put in charge of formulating and validating the methodology and tools to define the research priorities of the National Research Strategy, to supervise its implementation and evaluation.

Create a Parliamentary Commission dedicated to HE and R&I

The Tunisian Parliament is not presently involved into R&I policies, apart from yearly discussions about the State budget. Universities and research actors have no opportunity to express their needs to members of Parliament. There is no space for democratic debate about the needs of citizens and society concerning higher education, research and innovation. The national research priorities and their implementation should be evaluated by a legitimate and skilled body. This body should also evaluate how new knowledge and technologies impact current and future laws.

5.1.3 Information base for evidence-based policy-making

Introduce regular R&I surveys

The lack of comparable statistics and data on R&I resources, stakeholders, activity and production on the basis of international references (OECD Frascati Manual, 2002) is a significant obstacle to any attempt to understand how the Tunisian system is evolving and how policy can effectively support the economic system. The last bibliometric study of Tunisian research was based on papers published in 2012-2013. Business data is limited and there is basically no data on the system of intermediaries, nor regular evaluations of these intermediaries.

It is necessary to build an information system in order to implement data-driven decision-making and allow the MHESR to focus on its strategic missions. Data from regular surveys should be used in R&I decision-making. At present, too many decisions are based only on the experience and knowledge of policymakers.

Gather data on financial flows for R&I for the whole system

Any discussion of strategies for increasing private R&D spending in Tunisia is beset by a lack of robust data on business innovation activity, on the interactions taking place in the NIS and on the impact and efficiency of public interventions.

It is necessary to gather data on financial flows for R&I between the different levels of the whole innovation system. It is also necessary to improve the reliability and comparability of Tunisian spending data: at present Tunisian

statistics do not fully comply with the OECD Frascati Manual. Until this kind of information is available, stakeholders – companies in particular – should be consulted to prepare the changes and improvements suggested in this report.

Gather data to implement a S3-like approach

The collection of large-scale R&I data is a necessary step for priority setting in research activities, for a better understanding of business dynamics and for a realistic implementation of sector-specific intervention.

5.1.4 Training on strategy development

Provide training on strategy development to ministry staff

The majority of ministry staff is not currently trained to implement a strategic approach to R&I policymaking. It is necessary to implement training programmes on the strategic approach, evidence-based policymaking tools, and the culture of evaluation/quality assessment for ministerial staff responsible for research programmes and for managerial staff in research institutions. The training programmes should be integrated into the priority-setting process (i.e. learning-by-doing with the support of an international consultant, international expert group, or some other suitable expert body).

5.2 R&I governance issues

5.2.1 Implementation of research priorities

Develop methods to further specify priorities

The priority-setting process focuses research efforts towards socio-economic needs. However, at present it is more a list of topics of societal relevance, rather than research priorities. A problem-oriented approach, with a more detailed analysis of current problems and more explicit consideration of the potential contribution of research to specific problems would help in better defining priorities and in increasing the effectiveness of R&I policy.

The objective is to identify national niches and focus resources on areas where problems meet research potential, to provide a more concrete anchor for potential cooperation and to allow for a clearer positioning of Tunisian research. The focus could be on socio-economic needs and/or key technologies. Building on useful tools such as problem trees, logic models or value-chain analysis, mission-oriented approaches or smart specialisation strategies can be gradually developed.

A precondition for effective priority setting is a systematic evidence base. This is all the more essential if Tunisia aims to implement a smart specialisation approach. The continuation of the formal dialogue initiated with the national consultation on the priorities in 2017, and the support of informal networks oriented towards the challenges would also facilitate priority setting and ensure that they are specific and effective. Informal fora can provide a basis for smart specialisation partnerships or result in PRF on priority topics.

5.2.2 National funding of research priorities

Consolidate competitive research funding available across ministries

All ministries directly or indirectly involved in R&I issues should be involved in the implementation of the National Research Strategy and its six priorities. Increasing collaboration, communication and coordination between ministries with respect to inter-ministerial issues is of utmost importance in order to increase the efficiency of public effort in implementing priorities. The aforementioned inter-ministerial committee dedicated to R&I could be helpful in coordinating the programmes and tools of various ministries to focus resources on priorities and then to optimise public expenses.

In order to increase critical mass of research activity, it would be advisable to prepare and circulate a consolidated budget for R&I activities. The preparation of this document could provide a platform for institutionalising the discussion between ministries about their research strategies and expenses, consolidating competitive research funding, and greatly enhancing the inter-ministerial coordination. This public document should be organised around the national research priorities to help follow up implementation of the national R&I strategy.

Consolidate national R&I funding focusing on the research priorities

The call for the PRF for 2017-2019 was exclusively limited to the six national research priorities. PRF supports cooperation and synergies between multidisciplinary research teams and socio-economic stakeholders. However, the number of funded projects is too low to have discernible impact on priority implementation. Other ministries still define their funding allocation through temporary programmes.

5.2.3 Priority-specific networks

Set up priority-specific networks bringing together relevant stakeholders

As part of the recent government exercise to define research priorities, Tunisian authorities organised an inclusive consultation process involving some 2,000 stakeholders. The stakeholders included researchers, administrative and technical management, representatives of relevant ministries, as well as representatives of socio-economic organisations and civil society. However, while an online consultation was open to all stakeholders, it is not clear how representative the participation was.

Authorities should promote the creation of networks and platforms between stakeholders involved in given research areas. These networks should coordinate the local strategies and implementation of national research priorities, identify eventual critical factors, express the resources and capacities needed, and facilitate partnerships with the private sector.

Encourage informal dialogue between researchers and potential users

The private sector feels that business needs are not sufficiently accounted for in the definition of national priorities. This hampers the definition of collaborative projects with research institutions and technology transfer organisations. The MHESR and MoI, with UTICA, should facilitate the creation of virtual communities based on the implementation of the principle of Open Innovation, focusing on thematic areas and exploiting the support of the country's technopoles.

5.2.4 National and international research funding

Coordinate national research funding with bilateral and European programmes

It is necessary to foster the coordination of national research funding with bilateral and European programmes, especially in the priority areas. While this is in progress with respect to Horizon 2020, better coordination of research funding programmes from international sources and targeted applications for international funding opportunities would greatly increase the critical mass of research funding in priority areas, increasing the resources available to Tunisian institutions that strategically decide to specialise.

5.3 R&I and policy issues

5.3.1 Accountability and autonomy

Encourage universities to apply for the EPST status

Universities have very little autonomy in setting their strategies and spending research project funding (private, national, European or international), which is hampering their ability to attract external funding and promote initiatives for engaging with the private sector. However, academic institutions with an EPST status benefit from more autonomy than other institutions. The conditions for an institution to be eligible for this new status are hard to meet. The process is complex and too long. It should be redesigned.

The definition of appropriate strategic directions can only be implemented and managed well if more autonomy is granted, allowing freedom in the hiring of researchers, technical and administrative staff, building policies and maintenance.

The EPST status would encourage universities and research centres to encourage third-mission activities and promote the application of research priorities.

Make universities responsible for the success of laboratories

The Tunisian research system relies on a complex and wide system of laboratories and research units that report directly to the MHESR through an annual written report. Universities should be given the opportunity to become responsible for the activities of their laboratories, as an intermediate strategic and management organisation: the reason why universities have been created. This would increase their capacity to steer research efforts, alleviate the administrative burden of

laboratories and increase the accountability of their activities with respect to academic engagement. Moreover, universities could have more power in rewarding the best laboratories and rationalising the whole lab system (e.g. promoting mergers). Then the MHESR could focus on its own real strategic missions.

Laboratories should report to their parent university, which should aggregate information on their activities and report (be accountable) to the MHESR.

Three wardship tools (performance contract, mission letter and yearly target letter to the director) can help to coordinate relations between autonomous institutions and the MHESR. The autonomous institution is still a public operator.

Simplify the structures within universities by increasing the size of labs

Public research efforts are fragmented, with many research institutions and small laboratories with limited budgets and heavy administrative tasks. The minimum number of researchers per laboratory should be set around 50 FTE in order to increase critical mass and accountability of their activities. The rationalisation of the number of laboratories and research units should be based on a scientific basis, looking towards potential complementarities and collaborations. The priorities could be a framework for this organisational change.

While labs usually work better if researchers share the same working space, labs could also be shared across several research institutions, involving researchers with similar research interests or specialisation in priorities set by the MHESR.

Introduce a "researcher status" criteria for career evaluation

While the researcher status in Tunisia is *de facto* a HE teacher status, with no specific valorisation of other activities (research activity, expertise, international collaborations, partnerships with companies, start-up creation, third-mission activities), some ministries have their own research community. There is no human resources coordination between ministries, even if human resources make up a large part of research costs. Currently, it is not clear whether there are plans to redefine the researcher status and there is still no agreement over a common research strategy for human resources and skills development, nor an international scientific collaboration strategy.

It is advisable to introduce the "researcher status" describing clearly the main activities that characterise the work of this fundamental figure in innovation policy. All these activities (e.g. patenting or PPPs) should also be considered in recruitment, evaluation and promotion criteria.

5.3.2 Academic engagement

Remove administrative hurdles currently preventing collaborations

Research institutions crave leaner administrative processes as they believe that their research performance and third-mission activities are both hampered by this lack of freedom. More autonomy and responsibility should be given to

research institutions in order to reduce red tape and foster the creation of partnerships.

Universities and research centres should be made accountable for their strategies, which should include objectives on third-mission activities. They should be able to recruit staff according to the criteria set by the MHESR and carry out daily management of the laboratories. They should also be able to steer the research specialisation of the laboratories, promoting mergers and growth of the most valued or 'virtuous' labs on the basis of the criteria set by the MHESR.

Revise the researchers' career systems to create incentives to cooperate

Tunisian researchers are motivated to publish as many articles in high-quality scientific journals as possible because this is what defines their career. There is little recognition (and incentives) in undertaking applied research. Collaboration with the private sector is also not rewarding in terms of career: openness to the socio-economic environment is not part of the criteria for hiring or for career appraisals, and third-mission activities are not considered in career progression and evaluation (spin-offs, patents, fundraising, etc.). Secondly, researchers and labs have limited freedom to spend money earned from collaboration with businesses because of low spending autonomy. Thirdly, at present there are no monetary incentives for researchers and/or labs to establish collaborations. The career system should consider, or at least not discriminate against, third-mission activities.

Create monetary incentives to cooperate with private sector and knowledge users

There are few incentives for researchers to engage in UI partnerships. Current university policies at best tolerate commercialisation efforts. Those researchers that choose to respond to the government call for a stronger involvement with society and the private sector should be rewarded for their efforts. Research institutions should reward faculty members financially for their licencing activity and for their commitment to collaborating with companies.

Revise IP system (introduce professor's privilege)

The IPR system adopted in Tunisia might not be appropriate for spin-off promotion and appears better suited to a more R&I-intensive economy. It would seem more appropriate to reform the country's IPR system in favour of the adoption of the so-called professor's privilege. The professor's privilege grants to university professors and researchers the exclusive IPR to their inventions, and it grants royalties to the parent institution.

5.3.3 Effective intermediary organisations to support policy implementation

Increase independence of evaluation and funding decisions

Research institutions depend almost entirely on public funds. CNEARS depends on the MHESR, therefore it is not an independent agency as in some other countries. The evaluation criteria are not transparent, and the results of assessments are not published. Moreover, while a self-evaluation form for

university laboratories is available, the criteria on the basis of which the evaluation is done are not public.

Professionalise the staff employed in technology transfer intermediaries

The Tunisian R&I system is very complex, involving many actors. The system is in rapid change, with several intermediaries being created (e.g. technopoles and TTOs), but they are not staffed by properly skilled or trained personnel.

Proper investments in appropriate management and in skills development are needed if Tunisia wishes to maintain the current network of intermediaries model. TTOs are often empty shells and there is no guidance for researchers on IPR and research commercialisation.

There is no strategic vision for the role of technopoles in the NIS and they do not operate according to a given set of national research priorities, nor to real industry needs.

5.3.4 Effective support programmes

Rework existing programmes for innovation

The evaluations of PNRI and PIRD were rather critical concerning the overall design and implementation of these programmes. Although the objective of the PNRI is to encourage collaboration between companies and the public sector, the way the programmes are structured reduces the potential benefits that mutual learning and knowledge transfer may accrue. The central role of the technical centres in PNRI, which gives them the exclusive right to assemble prototypes, restricts learning on the side of companies. Therefore, the role of companies in these schemes should be increased.

Both programmes are characterised by substantial red tape and vague application and evaluation processes that require broad and often tedious procedures to obtain data on the company's side, as well as opaque decision-making structures. Companies also complain that decisions are taken without the support of independent experts, that procedures are lengthy and financial support insufficient. Therefore, it is necessary to simplify procedures and make them more transparent.

Maintain level of funding for PRF and the institutional bonus

The MHESR has some instruments to steer funds towards research priorities. While the PRF call is limited to the six national research priorities, a 10% bonus of the recurrent institutional funding was introduced in 2017 for laboratories and research units focusing on research priorities. This is a good practice that should be maintained in order to encourage institutions to specialise and target their research activities.

Use a method to deal with risk

A method developed for start-ups should be used to deal with the inherent risks and uncertainties of creating new support policy measures in Tunisia. The lean start-up (or lean innovation) approach suggests developing hypotheses that are tested and, once validated, implemented in policy interventions. In essence, it is a purely data-driven process that deals efficiently with uncertainties and tries to find solutions that work with as little resources as possible. The use of methods such as this would help reduce waste of resources.

Use international cooperation programmes to address knowledge gaps

Gaps between important needs and capacities can be targeted by specific policies, such as knowledge-intensive FDI, attracting foreign researchers, or priority areas for new research labs, groups or laboratories, as well as international cooperation. The MHESR DG for Horizon 2020 already tries to identify overlaps between European research funding opportunities, national research strengths and the national research priorities. This process could be key to addressing knowledge gaps in areas that are important for knowledge users.

Seek dialogue with individual companies

Business awareness about R&I activity carried out in the national system is very low. It is necessary to stimulate the involvement of businesses in priority setting and in the identification of their demand for innovation.

Research institutions must be made aware of current technological needs and identify the potential areas of collaboration.

UTICA and the professional associations should create networks and promote discussions between their members about their needs and mutual R&I activities.

5.3.5 Absorptive capacity

Support traineeships in all disciplines

Human capital in firms must be improved in order to address the problems of absorptive capacity. it is necessary to extend existing traineeship schemes to all university subjects. At present, only some undergraduate programmes, such as business courses and engineering degrees, have compulsory traineeship programmes in their curricula. Traineeship schemes could also include a model where the traineeship would be based on an existing company problem/challenge or opportunity and implemented by an interdisciplinary team of students under the guidance of the university.

Involve firms in curricula design

Universities could involve representatives from the private sector and from industry associations in the design and yearly evaluation of academic courses. This practice is common in several European countries especially in high-tech sectors such as aerospace.

Entrepreneurship education

Entrepreneurship education should be promoted. Initiatives in this area should also address R&D management courses for business representatives. This would help in reducing the problems with absorptive capacity and reduce the cognitive distance between businesses and research institutions.

The innovation challenges for master's degree students are only bi-annual. They could be done once a year by involving companies or professional associations (to define a theme and pay for the prize). Another yearly contest could be created to improve innovation and entrepreneurship culture for doctoral candidates. Those contests could be done in the area of the six national priorities.

APPENDICES

APPENDIX A: EMPIRICAL EVIDENCE ON R&I IN TUNISIA

Setting a target for R&D spending is difficult if the baseline is not known. For policy formulation and target setting, the number of R&I-performing companies, the R&D intensity as well as spending patterns at the sectoral level are a must. As the official numbers of business R&D spending are an estimate, no sectoral disaggregation is available. Nonetheless, there are at least three sources that somewhat advance the understanding of R&D spending of companies and their innovation activities in Tunisia:

- A survey by the World Bank contains R&I related indicators for 2013. The survey is an unweighted sample of Tunisian firms. It is fair to assume that innovators and R&D-performing companies are overrepresented in the sample as their likelihood to respond to the survey is significantly higher than for non-innovators. Despite this bias, these are the only recent numbers on innovation and R&D available that allow for some international comparisons and a rough estimation of the number of R&I performing companies.

- The innovation survey conducted in 2005 also sheds some light on innovation behaviour of Tunisian companies although the numbers are not weighted either. This survey is relevant with respect to the innovation behaviours of Tunisian companies in the 2002 to 2004 period. The next chapter presents the main insights into the innovation behaviour of Tunisian companies based on studies that used this innovation survey while we focus on numbers of R&D performing companies here.

- The third source of information on R&I spending are applications to Tunisian support programmes. As the programmes will be described in Section 3.2.3, we will only take the number of participants from programmes that focus on R&I as an estimate of R&D performing companies in Tunisia.

All of the three sources come with limitations, but using them in combination should allow us to get a rough understanding of how many companies might perform R&D and/or innovate in Tunisia.

Table 12: Innovation and technology related indicators for Tunisia (2013)

Subgroup level	Percent of firms using technology licensed from foreign companies*	Percent of firms having their own Web site	Percent of firms using e-mail to interact with clients/suppliers	Percent of firms that introduced a new product/service	Percent of firms whose new product/service is also new to the main market	Percent of firms that intoduced a process innovation	Percent of firms that spend on R&ampD
All countries	14,6	44,1	71,3	36,7	65,7	33,7	16,0
Middle East & N.A.	6,6	47,2	64,9	26,0	63,7	30,8	11,1
Tunisia	8,1	66,3	93,6	27,6	55,2	35,2	18,0
Manufacturing	8,1	69,4	94,1	36,9	61.7	39,9	25,7
Services	..	64,0	93,2	20,8	46,8	31,8	12,3
Food	1,8	65,8	89,3	18,0	56,2	28,4	7,5
Garments	10,5	61,3	92,8	19,3	57,6	29,0	12,0
Other manufacturing	9,1	71,9	95,4	44,9	62,5	44,8	32,8
Retail	..	45,6	92,1	12,1	n.a.	26,4	8,1
Other services	..	66,0	93,3	21,8	49,0	32,5	12,8

Source: World Bank, Enterprise Survey.

Note: Sectoral figures are for Tunisia only.

The World Bank has collected a number of technology and innovation indicators from companies with more than five employees that allow benchmarking of Tunisia vis à vis all countries in the sample and the Middle East and North Africa sub-group. Tunisia performs in general better or on par with the Middle East and North Africa group with the exception of the percentage of firms whose new product/service is also new to the main market.

According to the World Bank, 27.6% of manufacturing and service companies (n=592)[44] surveyed in Tunisia introduced a new product or service in 2013. More than 55% of these product and service innovations are considered new to the main market the company is serving. Slightly more than one third of companies introduced a process innovation while 18% invested in R&D. There is of course a substantial overlap between product and process innovators and R&D spenders. Regrettably, the share of companies that either engage in product and/or process innovation and/or R&D is not published by the World Bank.

At the sectoral level, the patterns are close to more advanced countries, i.e. the share of companies that focus on product or service innovation is substantially higher in manufacturing than services (36% vs. 20% in services), and particularly high in other manufacturing (45%) while in food and garments about 20% introduce product or service innovations. Manufacturing also scores higher in the introduction of process innovation, although the distance to service companies introducing process innovations is substantially smaller (40% vs. 32%). In terms of R&D spending, about twice as many manufacturing companies report investments (25.7% vs. 12.3%).

[44] The World Bank addressed companies with more than 10 employees. The firms responding represent about 10% of all companies with more than 10 employees in Tunisia.

Table 13: Technology and innovation indicators by size class (2013)

Economy	Subgroup level	Percent of firms using technology licensed from foreign companies*	Percent of firms that introduced a new product/service	Percent of firms whose new product service is also new to the main market	Percent of firms that introduced a process innovation	Percent of firms that spend on R&D
All countries		14,6	36,7	65,7	33,7	16,0
Middle East & N.A.		6,6	26,0	63,7	30,8	11,1
Tunisia		8,1	27,6	55,2	35,2	18,0
Tunisia	Small (5-19)	3,5	28,0	45,3	32,2	14,1
Tunisia	Medium (20-99)	10,7	27,1	70,0	39,0	22,0
Tunisia	Large (100+)	13,0	27,1	62,5	39,6	25,2

Source: World Bank, Enterprise Survey.

Disaggregating these figures shows almost no difference in the percentage of companies that engage in product or service innovation across size classes. This is highly unusual. Still, medium-sized and larger companies tend to introduce market novelties more often than smaller companies and are more likely to introduce process innovations and spend on R&D. Although there are some expected differences in the behaviour of small and large companies, the difference is less than could be expected.

The World Bank dataset also contains disaggregated data for exporters (>10% export share) and non-exporters, regions in Tunisia and male and female top managers. Based on these datasets, exporting companies as well as female top managers – although the latter group is underrepresented – tend to engage more often in innovation and R&D activities. Regional disparities are substantial, reflecting to some extent industrial specialisation in the regions.

The 2005 innovation survey collected data from 542 companies. While some of the indicators overlap with the World Bank survey, others allow a glimpse of different aspects of Tunisian companies' innovation behaviour. The innovation survey distinguishes between domestic and non-resident firms (i.e. firms with a foreign capital share of more than two-thirds). More than half of the companies in this sample (51.4%) introduced a product innovation, 48.6% a process innovation between 2002 and 2004. Thus, the share of product innovators is almost twice as high in the innovation survey, that of process innovators is about one-third higher. If the share of companies that have a R&D budget is taken as an indicator of R&D spending, the observed level in the 2005 innovation survey is equal to the share of R&D performers in the World Bank survey (15.7% vs. 18%).

The indicators on cooperation activities point at substantial interaction with universities (10.6%), research centres (5.3%), laboratories (6.5%), local public institutions (17.6%), and foreign firms and organisations (11.1%). These figures contrast heavily with impressions gathered during the country visits in 2018. The dominant view was that there is very little cooperation between science and industry for reasons described above. Of course, this may be due to missing statistics as many cooperation agreements may take place without being noticed by policymakers and experts.

Table 14: Indicators from the 2005 innovation survey in Tunisia

	Non resident firms (%)	Resident firms (%)	Total sample(%)
R&D unit or department	7,9	21,1	17,4
R&D budget	7,3	19,0	15,7
High and medium skill employees/total employment	22,9	27,1	25,7
Product innivation	32,9	58,5	51,4
Process innovation	41,4	51,4	48,6
Patent	2,5	4,0	3,6
Coop with universities	3,7	13,3	10,6
Coop with research centers	1,8	6,7	5,3
Coop with laboratories	0,0	9,0	6,5
Coop with local public institutions	14,0	19,0	17,6
Coop with foreign firms and organisations	11,0	13,5	11,1

Source: El Elj (2012)

The direct comparison between the World Bank and innovation surveys suggest that innovation activities – particularly product innovation – were substantially higher in the past. Given the limited information about the methodology of the surveys, it is not possible to know which one might be closer to reality. Also, a substantial change in the innovation patterns in those 10 years that separate the surveys cannot be ruled out.

Overall, there seems to be an upward bias in both surveys, i.e. companies that are innovative, exporting and/or larger may be more likely to answer the questionnaires. As there is no information on the groups that did not respond to the survey (i.e. a non-response analysis), the size of this bias cannot be estimated. Thus, no conclusions should be drawn or measures developed based on the observed differences. The World Bank survey might still contain valid information for comparisons in the regions if the assumption holds that this bias exists in all surveys in the region and is of the same magnitude.

The World Bank and the innovation dataset might be employed to estimate the number of companies that engage in innovation and R&D, i.e. the universe of

companies that could be targeted by Tunisian policymakers in the first place. Therefore, we use a weighting procedure based on the share of innovators and R&D performers in the World Bank survey and numbers from *Statistique Tunisie* on firm demography to estimate overall numbers of innovators and R&D-performing companies. Given the biases already discussed, this is merely an exercise to get an understanding of the upper and lower boundaries of the number of R&I-performing companies.

Table 15: World Bank indicators on innovation and R&D in Tunisia by size class (2013)

Firm size	Number of firms in 2013	Percent of firms that introduced a new product/service	Percent of firms whose new product/service is also new to the main market	Percent of firms that introduced a process innovation	Percent of firms that spend on R&D	Number Percent of firms that introduced a new product/service	Number of firms whose new product/service is also new to the main market	Number of firms that introduced a process innovation	Number of firms that spend on R&D
(6-19)	11835	28	45,3	32,2	14,1	3314	1726	3811	1669
(20-99)	5048	27,1	70	39	22	1368	1378	1969	1111
(>100)	1739	27,1	62,5	39,6	25,2	471	430	689	438
Number of companies >5 employees	18622					5153	3535	6468	3218
Number of companies >19 employees	6787					1839	1809	2657	1549

Source: World Bank, Enterprise Survey, Statistique Tunisie, own calculations.

We use data on firm demography by size class. For example, there are 11,835 companies with 6-19 employees in Tunisia. If we take the share of companies that introduced a new product or services from the World Bank survey we estimate the number of innovative companies in this size class at 3,314. Repeating this exercise for the other size classes brings the total number of product innovators to 5,153. Using the same weighting procedure for process innovation renders 6,468 companies, and 3,218 R&D-performing companies. These numbers are obviously far too high and are a direct result of the biased sample.

As the number of non-innovative firms decreases over size classes, i.e. the share of innovators is higher for large companies, the bias should be smaller for larger company size brackets. Applying this weighting process to companies with more than 100 employees estimates the number of product innovators at 471, of process innovators at 689 and of R&D performers at 438. As there is no information on how these companies overlap (e.g. how many of process innovators also introduced process innovation or perform R&D), the overall number of innovative and R&D-performing companies is difficult to estimate. We might assume that it is somewhat larger than 700 companies. This can be seen as the upper limit of the number of R&D performers in Tunisia.

An estimate for the lower level of the number of R&D-performing and/or innovative companies can be inferred from the unweighted survey results. The unweighted World Bank sample contains 163 product and service innovators, 208 process innovators and 106 R&D-performing companies. The innovation survey monitored 139 product and service innovators, 279 process innovators and 94 R&D performing companies (see Table 15). These estimates are rather consistent despite the different survey dates and somewhat different definitions of product innovation (i.e. containing services in the World Bank sample) and R&D performance (i.e. identifying companies with an R&D budget in the innovation survey as R&D performing companies). Consequently, the number of product innovators over a three-year period would be at around 150, that of process innovators at around 240 and about 100 R&D-performing companies.

Table 16: Number of innovative and R&D performing companies in raw data

	Innovation Survey	World Bank Survey	Average
R&D budget/R&D performance	94	106	100
Product innovation/product and service innovation	139	163	151
Process Innovation	279	208	244
Sum	512	477	
Number of observations	542	592	

Source: El Elj (2012) and World Bank, own calculations

Another predictor of the number of innovative and/or R&D-performing companies is participation in support programmes. For this exercise, applications to the **ITP** (*Investissement Technologique Prioritaire*) programme for investments in priority technologies, the **PIRD** (*Prime d'investissement en recherché et innovation*) grants for investment in research and innovation, and the **PNRI** (*Programme National de la Recherche et de l'Innovation*) national programme of research and innovation provide a benchmark. More information on these programmes below. PIRD and PNRI support product and service innovation, while ITP is promoting investments in new technologies which might constitute process innovations. A small share of ITP support might be devoted to immaterial investments like R&D (see Hassan, 2015).

The number of successful applications between 2011-2013 – assuming that there is no overlap between companies applying in any of these years – amounts to 34 for PIRD, 17 for PNRI and 2008 for ITP. Thus, the estimate for product and service innovators would be 51 companies if based on successful applications for PIRD and PNRI. This is clearly below the numbers in the surveys. The estimate of the number of potential process innovators based on ITP is far higher at around 2,000.

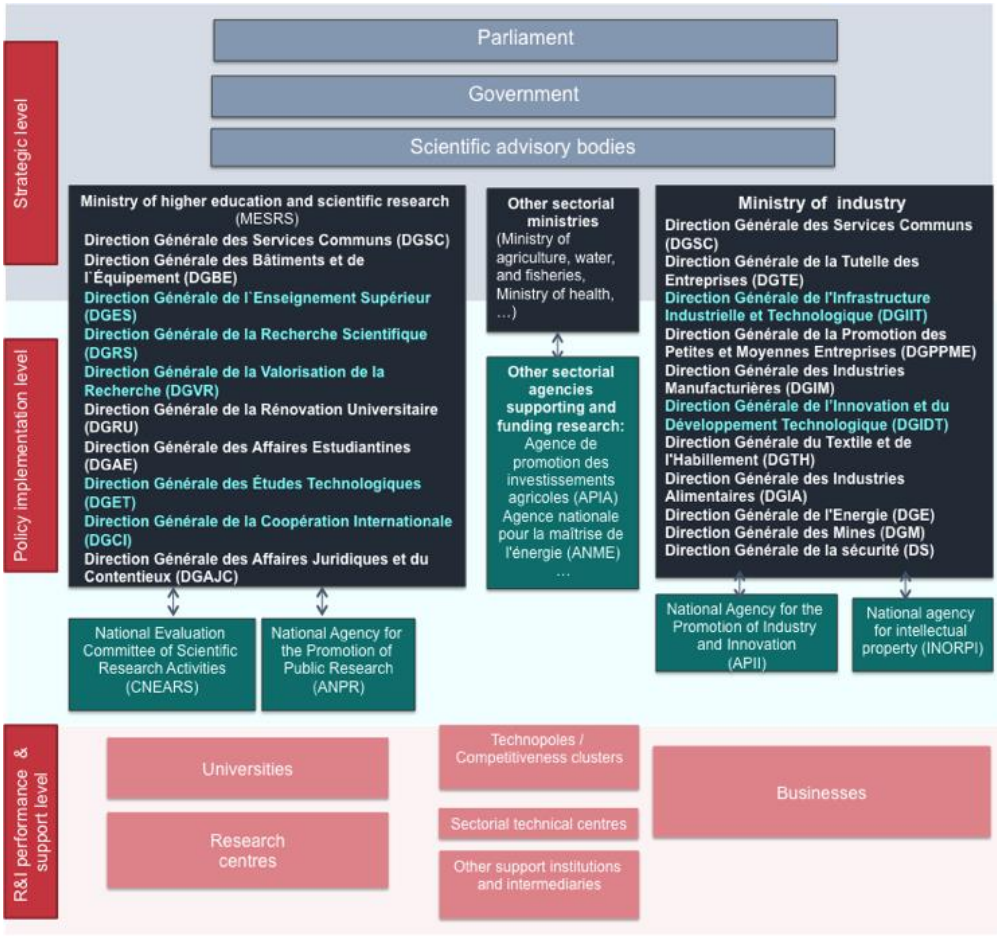
Given that not all companies apply for support when developing new products, and that there is no complete overlap between product and service innovators and R&D performing companies, a rough guess for the number of product-innovating and R&D-performing companies would be around 200 or higher. It seems reasonable to assume that this is the lower level of companies that form the basis of any strategy to increase R&D expenditures and/or enhance innovation performance.

APPENDIX B: THE R&I SYSTEM IN TUNISIA

The R&I governance structure

R&I policy in Tunisia is developed, funded and implemented at the national level. Figure 6 presents the governance structure of the Tunisian R&I system in 2015. As noted in the Background Report (Dani, 2018), in recent years the political debate has been focused on the need for more concerted activities and a more inclusive decision-making process to shape the Tunisian R&I system and foster R&I performance.

Figure 6: Simplified representation of the governance of Tunisian R&I system



Source: Adaptation from Hassan (2015) in Dani (2018).

At the political level, Parliament (i.e. the "*Assemblée des représentants du peuple*") and government ensure the highest level of governance. As noted in the PSF Background Report (Dani, 2018), they can be assisted by advisory and/or coordination bodies. However, the bodies that supported orientation and programming functions such as the National Advisory Council for Scientific Research and Technology (CCNRST), the Higher Council for Scientific Research and Technological Innovation, and the High-Level Council for Science and Technology are no longer active. The post-revolution period has impacted the strategic level with many of the RDI advisory bodies becoming inactive.

The Ministry of Development and International Cooperation (MDIC) coordinates Tunisia's Five-Year Development Plan. This plan defines the strategic orientation of all public policies that have an impact on the economic and social development of the country, including R&I.

At the interface between the political and policy implementation level are the MHESR, the MoI, and sectoral ministries with responsibility for R&D in certain fields such as health, agriculture, ICT, environment and energy. In particular, the Ministry of Technology and Digital Economy promotes the digital economy and – but not exclusively – entrepreneurship. Sectoral ministries (e.g. agriculture or health) also run R&I promotion activities and programmes.

The MHESR and the MoI are in charge of policy development and financing, its management and monitoring. The MHESR has the following functions:

- To design and implement HE and scientific research policy;
- To supervise the activities of HE and other research institutions;
- To oversee students' activities and coordinate university services;
- To coordinate and monitor HE and scientific research international cooperation activities.

The MHESR is supported in its mission by the ANPR, a public agency with administrative and financial autonomy, which was founded in 2008 in the attempt to overcome the sectoral approach to R&I policy. The agency gathered all stakeholders to agree upon a common Innovation Agenda and has the mission to assist the implementation of R&D programmes and initiatives, facilitating technology transfer (TT) through collaborative projects and the public-private-partnerships (PPP). The MHESR has also launched the pilot phase of the implementation of the first generation of BuTT (*Bureau de Transfert de Technologies*), i.e. Technology Transfer Offices (TTO). Thirteen universities, research institutions, research centres and technology parks were selected for the pilot. The activities of the TTOs are coordinated by the ANPR.

The MoI has broad responsibilities, measures and programmes to promote R&D in the private sector. The MHESR focuses on the interaction between industry and science as well as the intersectoral mobility of researchers. The mission of the MoI is to develop and implement government policy in support of the national

industrial sector and industry-related services. With reference to technological innovation, the MoI has the following functions:

- To contribute to the definition of the government technological innovation strategy;
- To design and monitor programmes for the promotion of technological innovation;
- To participate with other ministries (e.g. MHESR) in the definition of training programmes in the area of innovation;
- To design action plans for the development of sectoral technological capacities;
- To participate and contribute to the implementation of studies for the development of technology transfer activities;
- To design and monitor applied research programmes targeting industry;
- To ensure the involvement of businesses in technopoles and technical centres. The Ministry is also responsible to act if the performance is poor;
- To administrate applications for financial benefits allocated to investors in the areas of innovation and technological development.

The MoI is supported by the APII, whose mission is to spread the innovation culture among businesses by promoting capacity building programmes and incentive mechanisms. The APII has five intervention centres with representations in 24 regional offices. It was founded in 1972 and provides support services to entrepreneurs and enterprises. Among the five intervention centres, the Centre for Innovation and Technological Development (CIDT) is responsible for the promotion of innovation with a particular focus on SMEs. The centre is in charge of identifying business with innovation potential, offering an innovation diagnosis to businesses, and supporting in the implementation of their innovation projects. The CIDT also acts as a node in the Enterprise Europe Network (EEN), supporting SMEs in their internationalisation, innovation and technology transfer projects. Within this context, the agency organises the 'Days of technology transfer' in cooperation with the MHESR, which has been facilitating business-to-research encounters, coupling 'mature' research products with industry needs. The APII also organises biennal national innovation contests, which have been funded under PASRI since 2014 and target research centres, start-ups and individual researchers.

The Industrial Capacity Upgrade Office (BMN – Bureau de Mise à Niveau) is in charge of the implementation of the industrial capacity upgrade programme (PMN – Programme de Mise á Niveau) and the Investment in Priority Technologies (ITP – Investissement Technologique Prioritaire), operating under the auspices of the Ministry of Industry to evaluate and deliver a certificate of innovation to industrial companies who will apply for it.

The *Caisse des Depots et Consignations* (CDC) deserves one special mention. The CDC is a public financial institution established in 2011 and works together with other similar institutions in Africa and Europe (Italy and France). Its mission is to support State policy, mostly large structural projects and national innovation in SMEs. For example, the CDC funded the creation of technopoles and incubators and manages a finance line opened by the World Bank in support of early-stage companies. While the CDC is independent from ministries, its surveillance body is driven by the MoF.

Actors in the R&I system

Research activities are highly concentrated in national public R&D-performing institutions such as universities and research centres. The national R&I system also counts several technical centres and technology transfer intermediaries (see Figure 7). The role of the regions in R&I governance is very limited even at research-performance level. We identified four types of actors in the R&I system:

- The first group includes public research performers: 14 universities; 39 research centres; 316 laboratories; 327 research units. These actors are coordinated and receive funding by the MHESR. The country's academic system is organised according to a pyramidal university framework including faculties, departments, laboratories and units, which are small research groups (up to six people) lasting not longer than three years. Researchers working at research centres are recruited on the same criteria as in universities and are often detached academics. They are often engaged in fundamental research. Research centres have the same legal status as the labs in the universities.

- The second group includes technical centres (centres technique). They provide services and have the function of helping industry with testing, prototypes etc. Few centres are also active in research. They are similar to the Belgian 'Collective Research Centres'. Various measures have been set up to support these centres. They are all funded and coordinated by the MoI. Projects are the key sources of funding for the centres. Proposals are made bottom-up by the centres and financed by the MoI. Despite some interaction with industry, these centres generate little innovation activity.

- The third group includes innovation spaces. In this group we identify clusters and technopoles (Figure 7). The difference between clusters and technopoles is that the latter have an 'economic space', hosting research centres, incubators, etc. while clusters are associations. Therefore, technopoles can be members of one cluster.

As noted in the European Cluster Collaboration Platform, a service facility launched by EC DG Grow,[45] clusters have mainly been established in recent years in Tunisia. In 2012, the French Agency for Development launched a pilot project for the development of one of the first Tunisian clusters – the Cluster Mechatronic.

[45] https://www.clustercollaboration.eu/international-cooperation/tunisia

The cluster community in Tunisia was established on a model similar to France's *Pôles de Compétitivité*. Tunisia Technoparks is a cluster association established in 2013. Tunisian clusters are active in the sectors of food, mechanical industries, electric and electrical industries, biotechnology and healthcare industries, environment and renewable energy, and in textiles and clothing.

The technopoles represent, at least at face value, the core Tunisian initiative in support of knowledge transfer (Figure 8). Technopoles have the objective to promote, private R&D links between research institutions and the business sector, promote regional development. Technopoles are government-owned companies and their chief executive officer (CEO) is generally appointed by the MoI. Technopoles involve several kinds of stakeholders and some of them host a technical centre. Their implementation and management, according to stakeholders, is based in some cases on collaboration between the MHESR and MoI. El Ghazala is the only completely public technopole (first technopole to be put in place).

Technopoles can include Centres for Technological Resources (CRT). They are meant to act as physical platforms for technological development, serving all the stakeholders present in the technopole. The only ones active so far are in the Technopole de Monastir and Technopole de Sousse. In Borj Cedria and Sfax they are about to be set up.

- The fourth group of actors is represented by intermediaries. In this group we include business incubators and TTOs. In the wake of the positive experience of some northern European countries and the US, TTOs have proliferated in Tunisia. They are hosted at national universities, research centres and technopoles. Tunisia counts at the moment 17 TTOs.[46] TTOs are supposed to act as an interface between researchers of the institution to which they are attached and the private sector. Their role is to set up a structured process for IP management and support. Since 2001, a programme of business incubators has been implemented in industrial areas such as technopoles and in research institutions. There are two types of incubators: some are depending directly on the technopole management. This, according to stakeholders, is the best functioning model. Others have dual management, with the technopole management body supported by the MoI, which supervises their operations. Currently, Tunisia has 28 business incubators47.

Public R&D performers operate under the umbrella of different ministries:

- Higher education and scientific research institutions and research centres are under the umbrella of the MHESR and other sectorial ministries (Ministry of Agriculture, Ministry of Health, etc.);

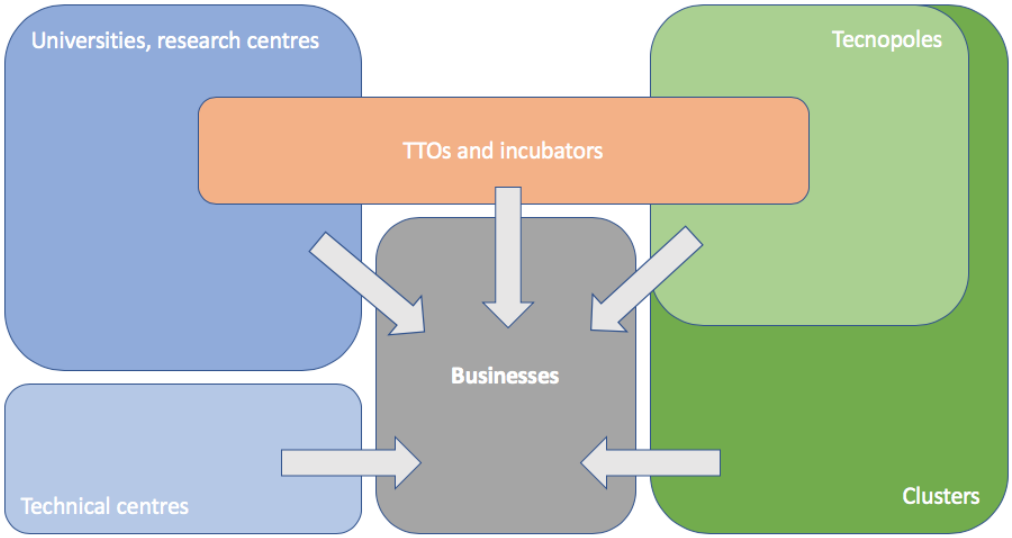
- Industrial technical centres work under the umbrella of the MoI.

[46] http://www.anpr.tn/les-butt-tunisie/

[47] http://www.tunisieindustrie.nat.tn/fr/doc.asp?mcat=16&mrub=138

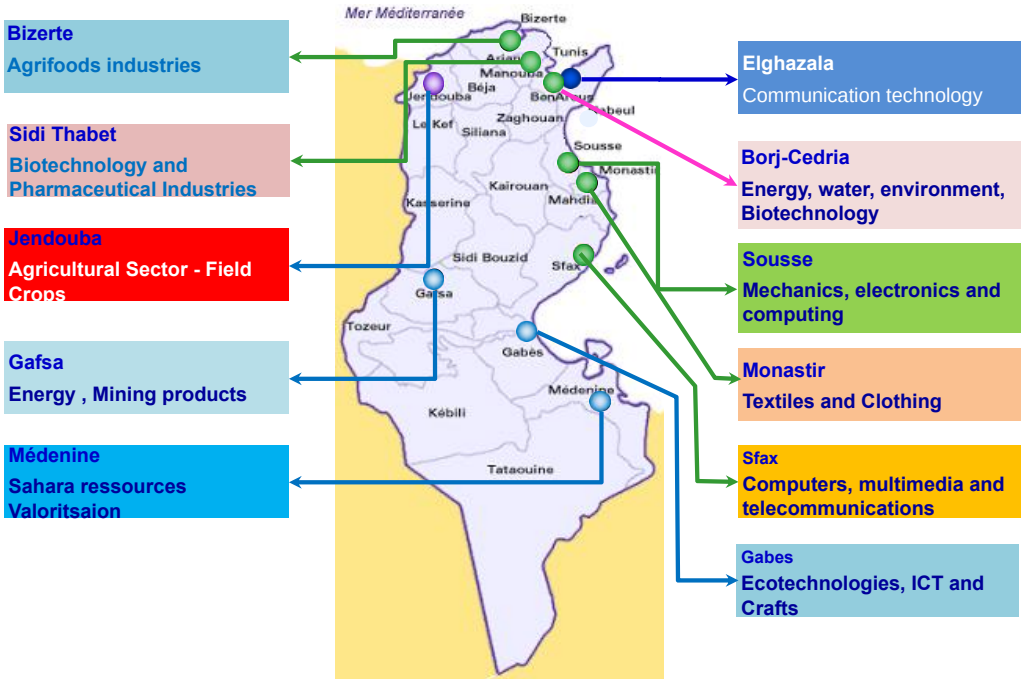
Other non-R&D-performing actors such as technopoles and clusters work following guidance from both the MHESR and the MoI, plus the aforementioned sectoral ministries.

Figure 7: The Tunisian innovation system



Source: authors' elaboration

Figure 8: Tunisian technopoles



Source: PSF Background Report (Dani, 2018)

APPENDIX C: RECENT DEFINITION OF RESEARCH PRIORITIES BY THE MHESR

In 2016 and 2017, the MHESR involved around 2,000 stakeholders in a national online consultation and in thematic and regional workshops[48]. From this process, six *défis prioritaires nationaux* emerged, also referred to as national research priorities.[49]

National consultation

The priority-setting process started with a nation-wide consultation open to Tunisian stakeholders, which took place in autumn 2016. The consultation took the form of an online survey entitled *Consultation nationale sur le theme: Recherche & Innovation: Vision, Priorités nationales et Gouvernance.* The website does not provide any further details on the context or objectives of the survey, but includes links to background documents such as the *Plan stratégique de la réforme (2015-2025)* by the MHESR, to reports by PASRI (Hassan, 2015), ESCWA (Khanfir, 2015) or UTICA's *Vision Tunisie 2020*. We also do not have any information on the dissemination of the survey, on the stakeholders invited to participate or on the response rate. A file provided by the MHESR (*Consultation results, Réponses au formulaire 1*), however, provides details of the participants: 483 stakeholders representing researchers, users from the private and public sectors, government agencies, as well as various intermediate actors, participated in this consultation.

In a first part of the survey, participants were invited to comment on the diagnostics and the recommendations of the PASRI Report. Just over 10% of participants took advantage of this opportunity. Participants were also invited to provide further background documentation to be added to the information available on the website. Accordingly, the information basis for participants may have expanded while the survey was online. The main part of the survey asked participants to take a position on six research areas defined by the MHESR and presented in Figure 9. In a first step, participants ranked the six thematic areas from one to six, in terms of their priority. No criteria were specified. In a second step, participants had the possibility to indicate sub-topics for each of the six themes. Participants were also given the opportunity to suggest additional themes, but only some 35 of them took did so.

The analysis of the responses showed that the theme *Water, Energy, Food and Agriculture* is frequently in the top three rankings (209 of 483 participants). It is also the theme ranked most frequently among the categories one to three, followed by *Medicine and Health Sciences*, and *Environment and Natural Resources*. The *Social Sciences and Humanities* were most frequently ranked as six and least frequently appeared in the top three priorities. This may due to the

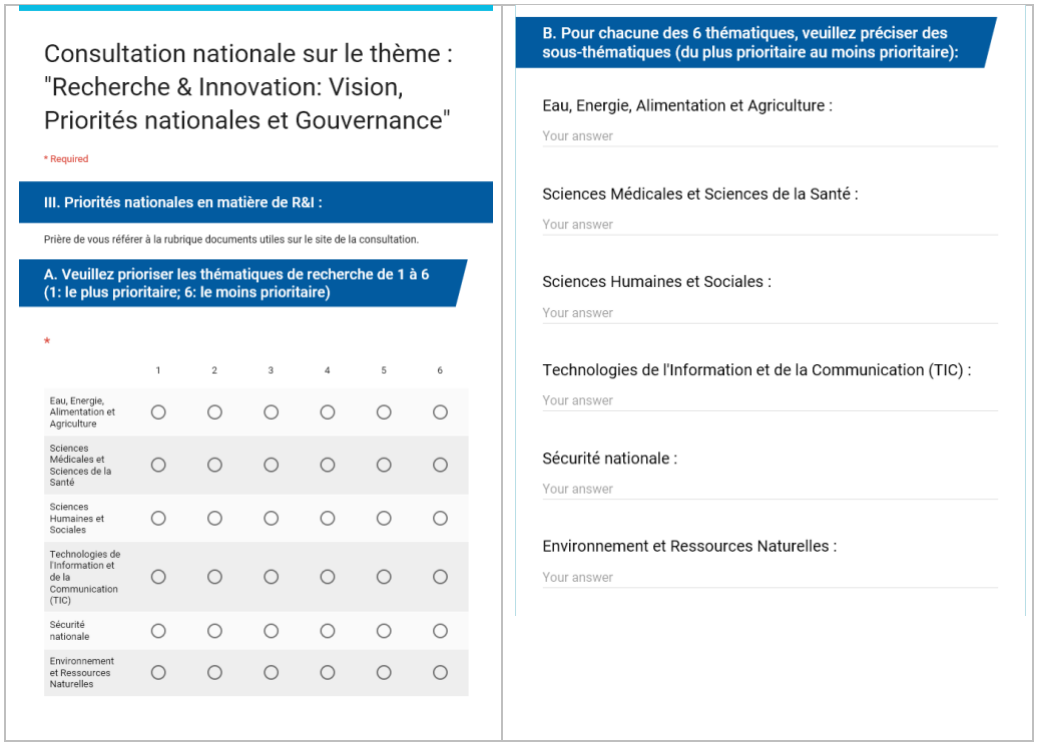
[48] MHESR, Recherche scientifique: priorités, orientations futures et initatives clés 2017-2022.

[49] Interview with Zghal (14.5.2018).

fact that a relevant issue for Tunisia as *National Security* was treated as a separate theme. The priority given to different subjects, of course, also depends on the mix of participants in the survey.

For each theme, between a third and half of participants suggested sub-topics. Some trends in the answers are apparent for the first theme *Water, Energy, Food and Agriculture*, with frequent references to desalination, water treatment, renewable, green and solar energy. For the theme TIC, the internet of things and big data are recurring references. In the context of *National Security*, anti-terrorism unsurprisingly was a recurrent theme. For the other themes there are no clear trends.

Figure 9: Extracts from the national online survey[50]



Source: MHESR, 2016/17

[50] http://anprtn.wixsite.com/prioritesnatr-i-1/consultation

Methodology and criteria for evaluating the priorities

While the survey was online, the MHESR organised a workshop with specialists in the six themes to discuss the methodology for the subsequent process and the criteria to evaluate the priorities (Table 17).

Table 17: Criteria used in national priority setting 2016/2017

Criteria	Sub-criteria
Importance of the current or potential added value	National or local societal impact (quality of life, sustainable development, contribution to social progress, positive regional discrimination, etc.) National or local economic impact (local demand, employment, exports, positive regional discrimination, etc.) Innovation and scientific excellence
Importance of alignment and commitments	Alignment with national sectoral or inter-sectoral strategies (security, health, agriculture, energy, transport, economy, education, etc.) International integration (the country's international commitments, conventions, etc.)
Feasibility (availability of resources and capacity)	Importance of the potential, and of existing resources and capacity: human, natural, financial, material resources, etc.) Feasibility of the RD&I given the context and the local and/or international environment Inclusive/cross-sectoral/multidisciplinary nature (synergy) of the RD&I
Level of urgency	Degree of urgency (e.g. dangers for the state or population: terrorism, epidemic, natural disaster, cyberattack, etc.)

Source: slides presented by Prof. L. Mezghani during Kick-off meeting, translation by the authors

Thematic and regional workshops

The results from the online consultation, and the criteria discussed above, then served as a basis for workshops in each of the six thematic areas, which took place in December 2016. In a next step, and after a consolidation of the results into 10 priority challenges, three regional workshops were organised in 2017 in Sousse, Gabes and Tunis. We do not have information on the participants in the different workshops, the organisation of discussions and the ways in which the results from the survey were incorporated.

Output

After the regional workshops and second round of prioritisation, the 10 priority challenges were reduced to six *défis prioritaires nationaux*, which were communicated in summer 2017. Each priority challenge includes a number of sub-priorities (see Table 18), which are described in further detail as illustrated for the topic *Water, Food and Energy Nexus* in Figure 10.

Table 18: National priority challenges (2017)

Societal project: Education, Culture and Youth
Identity, engagement and citizenship
Training (initial, continuing and lifelong), education and employability
Leisure, culture and quality of life
Radicalisation and spiritual life of young people
Public Governance and Decentralisation
Political and economic decentralisation
Local governance and participatory democracy
Models of development, land use planning and quality of life
Promotion of regional heritage and history
Quality of public services
Water, Food and Energy Nexus
Water resources (conservation, desalination, etc.)
Climate change and preservation of natural resources / biodiversity
Smart agriculture and mechanisation
Erosion of the coastline and desertification
Renewable energy and energy efficiency
Public Health
Quality of care
Demographic transition and well-being
Health priorities: epidemics, chronic diseases, new diseases
Governance and economics of health
Drug design - Development of vaccines and biosimilars
e-Health and telemedicine
Circular Economy
Development of agriculture and industry that respects the environment
Exploitation of mineral resources and useful substances (rare earths)
Fight against pollution and its effects
Waste processing and recycling: industrial wastewater and household waste
Digital transition
Digital economy
Smart Cities & IoT (Smart Grid, Smart Transportation) and Big Data
Security of networks and information systems
Protection and surveillance of borders and infrastructure

Source: slides presented by Prof. L. Mezghani during Kick-off meeting, translated by the authors

Figure 10: Example of the complete description of one of the priorities

Source: MHESR, 2016/17

APPENDIX D: RESEARCH AND INNOVATION

Numerous studies show that R&D is a major driver of economic growth and productivity. For this exact reason, increasing R&D investments ranks prominently amongst policy goals in many countries. But what makes it so difficult to increase R&D spending and why should (if at all) R&D expenditures be a target?

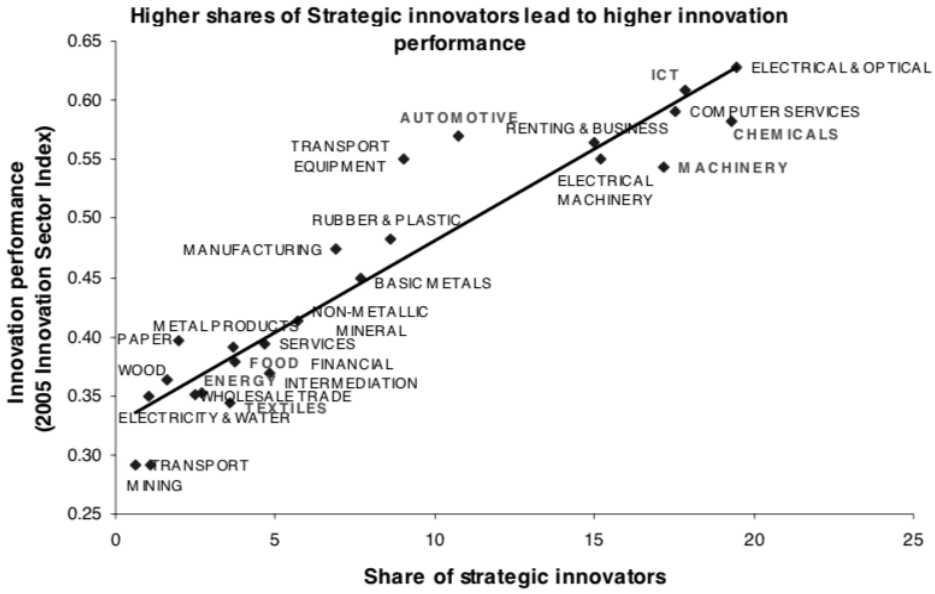
R&D spending is an input indicator that measures part of the expenditures necessary to develop an innovation or to acquire and efficiently use technologies developed elsewhere. The share of R&D spending in innovation expenditures, which is a couple of times higher than R&D expenditure, illustrates this. Being on the input side of product, process and service development means that they are a cost factor, i.e. something that companies would like to minimise rather than increase. Companies would prefer to spend the optimal amount on R&D to develop the product that gives a competitive edge rather than overspending on R&D. So, while policymakers seem to be keen on maximising R&D spending, managers strive to just spend the optimal amount.

At the firm level, quite different innovation strategies co-exist even at a disaggregated sector level. Hollanders (2008) – in defining four distinct innovation modes – shows that even in sectors investing strongly in R&D (e.g. ICT) companies that work at the technological frontier exist besides technology adapters, i.e. companies that depend on innovations developed by other firms. The composition of companies is different from sector to sector, but in no case are sectors populated by homogeneous firms. In other words, the variation in company strategies for R&I within sectors is even more pronounced than between sectors (see Leo et al., 2007).

The composition of those innovation modes determines the overall R&I intensity of a sector and is itself a function of the conditions for R&I a sector is facing (e.g. technological opportunities, market demand, appropriability conditions). In high R&D spending sectors the share of strategic investors[51] is high (see Figure 9). Thus, the more strategic innovators there are in a sector, the higher the innovation output of this sector. Expressed differently, innovation in some sectors depends strongly on own R&D efforts (e.g. ICT, chemicals) while in other sectors R&D is embodied in bought machinery and, consequently, the share of strategic innovation is lower.

[51] Strategic innovators are active on international and national markets and have introduced (at least) a product or process innovation that they developed (partly) in-house. Their R&D is a continuous activity. These firms are the source of many innovative products and processes that are also adopted by other firms.

Figure 9: Relationship between the share of strategic innovators and innovation output



Source: Hollanders (2008), based on Community Innovation Survey data.

There are three "lessons" in this work on innovation modes for the formulation of strategies to increase R&D spending:

- Firms may only contribute to R&D statistics if they are innovative, i.e. engage in R&D spending in order to develop new product, processes and services. Thus, the most basic interventions would aim at stimulating firms to engage in innovation activities. As discriminating against companies that do not invest in R&D when innovating should be avoided, increasing the number of innovative companies is the obvious target here.

- Given the positive relationship between the level of strategic innovators and innovation/R&D activities, increasing the share of the most advanced innovation modes is a straightforward policy prescription if R&D expenditures are to be increased. The potential contribution to R&D expenditures of within-sector upgrading strategies depends on the distance to the most advanced sectors that operate close to the technological frontier. It may be assumed that the catching-up potential at sectoral level is substantial in Tunisia.

- A significant departure from the current R&D-spending level depends on structural change toward high R&D-spending sectors so that the share of high R&D spending increases overall. This may be achieved by companies that diversify their activities or start-ups. Both add critical momentum to sectors by increasing competition that may trigger a virtuous circle which increases competitiveness on international markets. Without substantial structural change, catching-up towards the leading R&D-spending countries is not possible.

To summarise, higher R&I efforts may result from more companies starting R&I activities, companies upgrading their efforts, and an expansion of sectors that invest heavily in R&I.

It must be noted that the overall willingness to invest in R&I depends substantially on the environment and framework conditions as these determine the returns that may accrue to the company. The same logic holds for individuals and their investments in education.[52] Thus, creating a favourable business environment is a precondition for more specific R&D-upgrading strategies.

[52] For a discussion of extractive and inclusive economic institutions see (Acemoglu and Robinson, 2012).

APPENDIX E: ADDITIONAL INFORMATION ABOUT THE START-UP ECOSYSTEM

Improving the start-up ecosystem

In addition to public support initiatives, non-governmental organisations contribute to the creation of new companies through the popularisation of an entrepreneurial culture, and training for personal skills development (see APII, 2016). These include associations and institutions such as *Le Réseau Entreprendre Tunisie,* ENPACT, ELSPACE, Cogit, Education For Employment-Tunisie (EFE-Tunisie), and INJAZ-TUNISIE.

With the financial support of international donors (e.g. European Union, United Nation Industrial Development Organisation (UNIDO), Qatar Friendship Fund (QFF) , Mercy Corps), new support programmes were initiated. Thniti by CONECT (Confederation of Citizen Companies of Tunisia) and the QFF is an example. The programme targets directly early-stage entrepreneurs from the regions of Siliana, Kef, Kasserine, Gafsa, Tozeur, Kebeli, Medenine, Tataouine, Gabes, Sidi Bouzid, Kairouan, Mahdia, Zaghouan, Jendouba and Bizerte. The initiative aims at sourcing 2,150 project ideas with potential, training of 1,250 project idea carriers, and coaching and accompaniment of 525 future entrepreneurs. An online platform called (Wajjahni.com) was set up to support this initiative.

Mashrou3i Programme is a public-private partnership project, put implemented and funded by the United Nations Industrial Development Organisation (UNIDO) in partnership with the Tunisian Government, USAID, the Italian Government and HP. It is based on entrepreneurship training through the HP_Life online training platform and intensive business coaching.

The Enterprise Europe Network Tunisia was launched in 2010 with the intention of helping companies, research institutions and agencies with their international expansion and participation in European framework programmes. The consortium behind the network is coordinated by the Agency for the Promotion of Industry and Innovation (APII) and brings together the Centre for the Promotion of Exports (CEPEX), the Chamber of Commerce and of Tunis Industry (Tunis CCI), the Elgazala Cluster of Technologies of Communication 'Technopark Elgazala', and the Confederation of Citizen Companies of Tunisia (CONECT).

In 2005, the law related to spin-offs was introduced to encourage and assist staff to start their own businesses. According to a study carried out by GIZ on the state of art of the spin-off in Tunisia and its impact on the business creation dynamics, 45 companies (private groups/public institutions) signed an agreement with the Ministry of Industry to accompany spin-off projects, thus guaranteeing tax deductions. But only 19 of the 45 companies followed through.

Coworking, incubation and acceleration

The strong increase of coworking spaces was supported by international donors (e.g. Hivos, IFT) and contributes to a more favourable atmosphere in which like-minded people gather to create start-ups. In 2018, 29 Tunisian coworking space are listed in the platform coworker.com. The LEAD programme –"coworking for sustainable employment" – by Hivos, Hivos Impact Investments and Mercy Corps is designed to contribute to the creation of more job opportunities for young people by supporting and setting up six coworking spaces from seven regions in Tunisia (Medenine, Tataouine, Tunis, Sfax, Kasserine, Sidi Bouzid and Gafsa) (LEAD, 2016).

At the end of 2017, the National Network of Business Incubators (RNPE) had 27 business incubators that are related to an academic institutions (ISTE, engineering schools, see RNPE, 2017). These 27 public incubators (*pépinière d'entreprise*) hosted 118 enterprises, 73 of them were created in 2017. The total investment is 7,163 million TND and 516 jobs were created.

Private business incubation, mentoring and acceleration and access to finance

Funding for start-ups is composed of a variety of financial instruments to meet the financing needs of Tunisian start-ups. Beyond the proliferation of microfinance institutions, private equity and venture capital markets remain at an early stage in Tunisia.

Tunisia has seen the creation of several private sector and civil society initiatives to support innovation and start-ups. The most significant entities are the following:

- Wiki Start Up was the first private Business Incubator launched by Carthage Business Angels network.

- Start Up Factory/IntilaQ for Growth Fund launched by the telecommunications operator Ooridoo and the Tunisian-Qatari Friendship Fund.

- ESPRIT Incubator is attached to a private university which leads in the field of ICT in partnership with the association Tunisie Croissance which is backed by Tuninvest Fund.

- Yunus Social Business is an accelerator managed by the Yunus Foundation in partnership with the African Development Bank to promote social innovation and contribute to the Social Business Development in Tunisia.

- EL SPACE is a social innovation hub that is building a sustainable community through entrepreneurship and innovation and offers services and training to budding social entrepreneurs.

- The Founders Institute organised the American Accelerator which provides early-stage and aspiring entrepreneurs with the structure, training, mentor feedback, global network, and support needed to start a viable company.

- Flat6labs provides seed funding, strategic mentorship, a creative workspace, a multitude of amenities, entrepreneurship-focused business training, and direct support. Twice a year, Flat6Labs offers between six and eight start-ups an investment of €36,000 in seed funding and services in exchange for 10–15% equity in the company. Flat6Labs Tunis expects to support and invest in more than 90 Tunisian start-ups within the next five years through its accelerator programme and early stage fund (USAID, 2016).

- Bi@Labs has an acceleration programme that rewards successful entrepreneurs with €13,000.

- WikiStart-up helps entrepreneurs with their business plan and introduce them to investors.

- IntilaQ used to be among the first early stage investors. Today it is the leader with a portfolio of over 26 start-ups. They are investing in start-ups looking for growth and in need of an investment between €300,000-600,000 (1–2 million TND).

- CapitalEase, managed by United Gulf Financial Services North Africa (UGFS), Capitalease II is a Seed Fund that targets innovative business sectors. With a size of €4.7 million (15 million TND). The fund not only finances companies in the seed phase but also companies in the development and growth phase to successfully penetrate the international market.

Access to finance for start-ups

Public support structures are more or less available for start-ups too[53]. Besides the already mentioned programmes that stimulate innovations (MAN, ITP, PIRD) and cooperation (PNRI) the following support measures to ease access to capital are in action:

- RIICTIC – Régime d'Incitation à la Créativité et à l'Innovation dans le domaine des Technologies de l'Information et de la Communication – is an incentive scheme for creativity and innovation in the ICT sector;

- FOPRODI – Fonds de Promotions et de Décentralisation Industrielle – is an industrial promotion and decentralisation fund to create a new generation of founders by promoting the creation and development of small and medium-sized enterprises in industrial, service and craft activities as a means of stimulating regional development;

[53] For a detailed overview of these instruments and programme see APII (2016).

- IN'TECH – This scheme aims to fund SME innovative projects or the creation of innovative start-ups. Funded projects have a value between 100,000 TDN and 5 million TDN. It is limited to 49% of share capital with a minimum ticket of 30,000TDN. IN'TECH is managed by Sages Capital;

- The institutional and regulatory framework for private equity investments has been strengthened in the aftermath of the revolution in 2011 and has led to an increase in the establishment of investment vehicles such as SICARs (Société d'Investissement à Capital Risque – investment companies), FCPRs (Fonds Commun de Placement à Risque – mutual funds dedicated to private equity activities) and FAs (Fonds d'Amorçage – funds for start-ups, e.g. IKDAM, SODINP, PHONECA, CAPITALEASE). Various tax incentives, coupled with a simplified legal and regulatory framework, have helped the private equity industry to develop somewhat in recent years. Private equity investments in Tunisia remain nevertheless very limited (European Investment Bank, 2015).

These are complemented by programmes that foster interaction with scientific institutions:

- VRR – Le Fonds de valorisation des résultat de recherche – is research commercialisation fund intended for laboratory researchers who join an industrial company for the three years of the project. It aims to encourage the transfer of innovation that can lead to industrial exploitation;

- PAQ-PAS provides funds for the creation of spin-offs by university graduates of up to 100,000 TND per project;

- MOBIDOC is a mobility programme for doctoral and post-doctoral students, supporting work placements in a company. Post-doctoral students get support for 24 months;

- PAQ Post PFE funds the 'valorisation' of outputs resulting from graduate training at the end of the studies with up to 35 000 TND per project over a one-year period;

- The PRF deals with priority national issues defined in consultation with the various stakeholders in the sector concerned.

Microfinance public and private

Microcredits are the instrument of choice of the Tunisian government. The public microfinance bank BTS (*Banque Tunisienne de Solidarité*) was established in 2000 and runs a network of 300 microcredit associations (*Association de Mircocrédit* – AMC) which grant subsidised loans. USAID (2016) finds a strong tendency of this network to finance low-risk projects only. In every case, the project volume must be below €17,000. Larger projects (i.e. >€17,000) are to be financed by the *Banque de Financement de Petites et Moyennes Entreprises* (BFPME) which was created in 2005. The bank finances the acquisition of capital and intangible goods (e.g. software, licences), the use of engineering services, and the provision of

working capital for new and established companies. The Bank finance is active in all sectors except tourism and real estate.

New Tunisian microfinance legislation created the statute of microfinance business and enabled the granting of licences to international MFIs and local investors to operate in Tunisia (USAID, 2016). ENDA Tamweel, Taysir Microfinance, Microcred Tunisie, Advans Tunisie and *Centre Financier aux entreprises* – to name the most important – were created since 2011; all under the legal form of *societé anonyme*. The interest rates charged by these microfinance institutions are prohibitively high so that they can rarely be afforded by start-ups.

Seed financing

Seed funding in the country ranges between €4,000 and €20,000, which is a small amount. Thus, the start-up will soon require another round of funding. If they do not manage to secure another round of funding, they won't will struggle to remain afloat and eventually fail. One additional issue in Tunisia is that funding networks are not sufficiently aware of all early-stage start-ups in the country (WAMDA, 2017). Start-up in Software development, agritech and creative industries raised in 2017 around $4.8 million.

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To support countries in reforming their research and innovation systems, the Directorate-General for Research & Innovation (DG RTD) of the European Commission set up a Policy Support Facility (PSF) under the European Framework Programme for Research & Innovation 'Horizon 2020'. It aims to support Member States and associated countries in improving their national science, technology and innovation systems.

The Tunisian government requested specific support from the PSF, as a basis for improving the definition of research priorities and promoting private participation in research and development.

The PSF panel of four independent experts supported by two national peers worked from March to December 2018, including two missions to Tunisia to consult stakeholders and discuss potential recommendations. This final report was formally presented to the Tunisian government and stakeholder community in Tunis during September 2019. The PSF panel identified three key policy messages that underpin thirteen more detailed recommendations:

1) Set up the right conditions for enabling effective R&I policy development

2) Strengthen synergies and coordination across R&I stakeholders and funding flows around well-selected priorities

3) Foster the engagement and performance of all key operators of the innovation ecosystem through well-designed incentives and support tools

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