Are Technoparks High Tech Fantasies? Lessons from the Tunisian Experience

Hatem Mhenni and Adel Ben Youssef and N Elaheebocus and Ludovic Ragni

Ecole Supérieure de Commerce de Tunis

January 2013

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Adel Ben Youssef[1], N. Elaheebocus[2], Hatem M'henni[3]& Ludovic Ragni[4]

Abstract

The objective of this article is to contribute to the debate on the effectiveness of Technoparks (TP) in developing and emerging economies using the example of Tunisia. This article is based on a thorough desk review and informal interviews with TP entrepreneurs and managers in Tunisia. Setting up "ex-nihilo" ten TPs in Tunisia in the mid-1990s was a political decision. Having signed the Treaty of Marrakesh to enter in a Free Trade Zone with Arab Countries in 1989, and being the first Mediterranean country to enter in a free trade area with the EU in 1995, Tunisia needed to boost its productivity and competitiveness both within the EU and with other Arab states. As a response Technoparks started burgeoning in an attempt to address new economic challenges such as demand for highly skilled labour, jobs for youth, economic diversification, capturing the dividend of new technologies, and boosting regional development.

In 1997, Tunisia set up El Ghazela --a competitive Technopark in Information and Communication Technologies (ICT). Six other TPs followed suit in various priority areas like biotechnology, energy, and agri-business which are still in progress. Tunisia's eleventh development plan programmed for an additional three TPs in the south and in the west of the country. Of the ten TPs only El-Ghazala is effective. A key success factor was the interaction between government, higher education institutions and multinationals as well as the diaspora which played a crucial role in attracting multinationals. They also effectively linked Tunisian start-up companies to the international value chain of production. El-Ghazala had access to a critical mass of highly skilled researchers and a local labour market. The other TPs failed to put in place some of these necessary prerequisites.

This article shows that setting up ten TPs in a small developing country like Tunisia was quite unrealistic. A better strategy would have been to concentrate on three or four specific centres of excellence such as performing universities or industrial zones and leverage the diaspora more effectively.

Key words: Technoparks, Centers of Excellence, Science, Technology and Innovation, Research and Development spillovers, Industrial Policy, Tunisia

JEL Classification: O3; O4

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[1] adel.ben-youssef@unice.fr; SJA 1 - Institut Supérieur d'Economie et de Management. 24, avenue des Diables Bleus 06357 Nice Cedex 04

2 n.elaheebocus@afdb.org –Senior Human Development Officer, African Development Bank, Tunis, Tunisia. The findings, interpretations, and conclusions expressed in this paper are entirely those of the author(s), they do not necessarily represent the views of the African Development Bank Group, its Executive Directors, or the countries they represent and should not be attributed to them.

[3] hatem.mhenni@essect.rnu.tn, Laboratoire de recherche LARIME. Ecole Supérieure de Commerce de Tunis. Campus Universitaire de la Manouba. 2010. Tunisie.

[4] ragni@unice.fr; SJA 1 - Institut Supérieur d'Economie et de Management. 24, avenue des Diables Bleus 06357 Nice Cedex 04

1. Introduction

Are science parks[5] high tech fantasies? This question by Massey et al. (1992) nearly two decades ago is still valid today. There is a heated debate in the field of Science, Technology and Innovation on the effectiveness of Technoparks (TPs). Since the 1970s, developed countries like the USA, France, Japan, UK and Italy, have implemented TPs to promote economic growth and foster technology-based sectors[6]. In the last 20 years, developing and emerging countries in Africa and Asia are beginning to replicate the TP model to boost their scientific research capacity and foster innovation, establish added-value industries, build human capital, create jobs, and increase their competitiveness in global markets. But, are TPs the answer?

Technoparks, the new buzz word in emerging economies: What are they?

There are many types of TPs ranging from business parks, incubators, science parks, industrial parks to centers of excellence. For the purposes of this article, we will refer to TPs as defined by the UK Science Park Association.

> *"A Science Park is used to describe a property-based initiative which (i) has a formal and operational link with a university or other higher educational institution or major centre of research; (ii) is designed to encourage the formation and growth of knowledge based businesses and other organizations normally resident on site; (iii) has a management function that is actively engaged in the transfer of technology and business skills to the organizations on site."*

The idea of setting TPs close to universities emerged because New Technology Based Firms (NTBF) were created by scholars and university staff. They were designed to support technology transfer, creation of businesses and jobs and enable academics at the local universities to commercialize their research ideas (Storey and Tether, 1998).

While policymakers strongly believe in the efficiency of TPs, due to a lack of evidence researchers tend to be more sceptical, especially in their effectiveness in developing countries. Authors like Massey et al. (1992) argue that TPs have no economic effect except for the real estate aspect. Colombo and Delmastro (2002) explain that the more the country is laggard in high-technology activities the more the TPs tend to achieve their goals. Since emerging countries like Tunisia lack prerequisites for technology-based growth, TPs were seen as a solution, especially for attracting technology based-industries and enterprises (Bakourous et al. 2002). Identifying what makes TPs successful is one of the most important research questions in this field.

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[5] In this article we will neglect the difference between Science Parks and Technoparks. Technoparks are supposed to be of a larger size (OECD, 1997).

[6] The first Technopark was established in the United States around Stanford University in 1951. The second, The Research Triangle Park, was based in North Carolina in 1959. European Parks emerged in the late 60s /early 70s in order to replicate the US success story. The first Technopark in France (Sophia-Antipolis) was created in 1969. The first Techno Park in the UK was established in 1972 around Cambridge University (Cambridge Science Park). Since then, several parks around the world have been created, especially in emerging countries aiming at technological catch-up and enabling their local universities to compete in the global innovation market.

In this article we first discuss the effectiveness of TPs in promoting innovation and attracting technological firms in Tunisia. Second, we evaluate the policies implemented in Tunisia in the management of TPs. Third, we critically analyse the policies implemented. Finally, we present some policy recommendations to upgrade the existing TPs.
Section two surveys the economic literature on TPs especially in emerging and developing countries. Section three describes the case of Tunisia and gives an overview of the National System of Innovation and the place of TPs. Section four provides the rationale of TPs in Tunisia and discusses their effectiveness.

2. Technoparks: Do they Really Work?

Capturing the dividend of new technologies and innovation is a priority for all countries. This can only be achieved if countries have a strong skill base (highly skilled researchers) and a vibrant private sector creating new and dynamic firms. The model of TPs works because the physical proximity between higher education institutions and New Technology Based Firms (NTBF), benefits the entire economy and raises scientific research and innovation in a country. These budding NTBFs need support such as access to technical, logistical, and administrative resources as they struggle to gain a foothold in an increasingly competitive market (Porter (1998)).

Often, due to market failures, NTBFs need strong support from decision makers (Colombo and Delmastro, 2002). Several theoretical arguments justify government interventions in TPs. Oakey (1995), states that NTBFs produce positive externalities. In fact, the benefits to society from establishing NTBFs exceed those of firms. Castells and Hall (1994) list three motivations for the establishment of Technoparks or Science Parks: (re)industrialisation, regional development, and creation of synergies. Since most countries face strong concerns with industrialisation and regional development, setting up TPs became a common answer to these problems. Colombo and Delmastro (2002), state that NTBFs are sources of radical innovation and unconventional technical approaches. By supporting these firms, governments create new industry segments. In the case of emerging countries, TPs compensate for the lack of basic preconditions for technology-based competition (e.g., missing markets, interactions and skills).

While theoretical arguments are well established and accepted, empirical evidence in favour of TPs is still an open question.

Ben Youssef and Quéré (1999) explain the positive dynamics observed at a renowned French TP "Sophia-Antipolis" in the quality of interactions between firms (cooperation and competition) and in which multinationals played a crucial role. Most of the entrepreneurs and founders of this TP were staff at big companies and/or sub-contractors. They also found that the existence of local labor markets with high profiles is one explanation of the TP's take-off. Colombo and Delmastro (2002) found that Italian TPs were successful in attracting high profile entrepreneurs. On-Park firms exhibited higher performances compared to off-Park firms in speed of growth and Research and Development (R&D). Colombo and Delmastro suggest that the positive findings may be explained by the country's level of technological innovation. *"A possible explanation may reside in the fact that Italy is laggard in high-technology activities."* The presence of

Scientific Parks and TPs may be relatively more beneficial where the national innovation system is less advanced. Zucker et al (1998) have found a positive interaction between universities and the Technopark of North California in the field of biotechnology. Lindelöf and Löfsten (2002) compared the performances of firms' on-Park and off-Park in Sweden and their findings show that on-Park firms have better performances in sales growth and profitability. Westhead and Storey (1995) found that the probability for a firm to survive is higher if the firm has a link with a university. Since firms that were established in a science park were more likely to have a link with a university, they argue, that the role of the science parks in the UK may prove critical for the survival of small high-tech firms.

From a technological policy perspective, these findings are helpful and can partly explain why policymakers in developing countries strongly support TPs.

Findings from Colombo and Delmastro (2002) research need to be confirmed by evidence from developing countries (assumed to be less technologically advanced). For instance, Massey et al. (1992) argue that science parks are not major sources of technology development. He asserts that geographical proximity between a university and a science park accounts for very little in promoting technology transfer. Science Parks are forms of prestigious real estate with few productive synergies generated. Similarly, Macdonald (1987) suggests that the premise that NTBFs have a competitive advantage due to their strategic location near a university is flawed. He is also sceptical about on-Park agglomeration economies. Bakourous et al. (2002) evaluated the performance of three science parks established in the mid-1990s in Greece and found that they were not successful. The three major factors explaining their findings are (i) due to their small size Greek firms do not fully capture the dynamic effects of TPs, (ii) the evaluation was made a few years after the existence of the Greek TPs. More time is needed to observe dynamic and positive effects; and (iii) the existing policy for TPs Management was not satisfactory (letting-in policy of the parks). They report positive informal interactions between industry and local universities but few formal ones. Eto (2005) questioned Japan's policies towards the promotion of TPs outside big cities (e.g., Tokyo, Kyoto and Osaka). Eto argues that cultural factors are the main explanation of the success of TPS. Firms are reluctant to set plants outside big cities where there are no cultural facilities. Since there is no local dynamic labor market in these cities the probability of success of setting TPs in these cities are low. His findings support Marshall's argument of existent local labour markets as a prerequisite for the development of TPs. In their study, Chan and Lau (2005) found no evidence of benefits from networking in Hong Kong-based incubators, and argue that perhaps networking is more relevant in Western contexts. Radosevic and Myrzakhmet (2009), show that Kazakh TPs are not successful in innovation and diversification of Kazakhstan's economy. Firms within these TPs are oriented largely towards the local market and operate in the traditional sectors. Williams (2013) show the difficulties in setting the Russian Technoparks. Beside an active policy by the Russian government and massive investments, "*the policy failed to address the issue of the formation of NTBF. There is no stimulus for small businesses to engage with R&D organisations to commercialise the research results. The formation of spin-off firms still has an accidental nature*." (Williams, 2013 – p. 7).

These examples show how difficult it is to implement TPs and how unpredictable and variable their results can be. These difficulties increase in the case of developing countries where there are scarcity of funds, a short supply of qualified researchers, few internationally competitive companies and a non-conducive investment climate.

The experience of Tunisia is particularly interesting because (i) there was a real political will to improve economic competitiveness by leveraging innovation; (ii) it is one of the first countries in the African and Arab regions to set up a new Technopark in the nineties and (iii) it is a developing country with no particular comparative advantage in ICT but who created a very competitive TP in ICT.

3. The Tunisian National System of Scientific Research and Innovation: an overview

In the late 1990s, building an effective National System of Scientific Research and Innovation became a priority for the national government. Tunisia has a well-developed public research system similar to most institutions in OECD States. But the system is fairly centralised, with the national government playing the lead role in science and technology policy as well as in funding development and education initiatives (Arvanitis and Mhenni (2010)).

Every five years, a National Development Plan sets the objectives of the research and innovation policies. Formally, policy planning and implementation are based on a rich network of policy design, implementation and advisory bodies as well as on evidence. However, efficient coordination of stakeholders in the overall process has been problematic.

Between 2007 and2012, a significant feature of the Tunisian R&D system was the high share of funding allocated to infrastructure: new Technoparks, new research centres, and access to international scientific information centres and databases.

At 1.1% of GDP in 2009,[7] Tunisia's level of R&D is relatively high compared to other Middle Eastern and African countries. The share of Business Expenditure on R&D (BERD) in the national effort is estimated at 20% of the Gross Domestic Expenditures on R&D (GERD). Public research organisations and university research units are the main actors in the research system, absorbing more than 80% of government allocations for R&D and delivering 67% of Tunisian R&D. The government's objective is to raise GERD at 1.5% of GDP by 2014, of which nearly one third should be funded by the business sector.

Education absorbs 20% of Tunisia's State budget (7% of GDP). But in 2010, a mere 36.9% of the population aged 18 to 24 had a tertiary level education and about one third of students were enrolled in science & engineering fields. This figure more than doubled

[7] Data published by UIS 2012, but they must be considered as provisional since the last R&D survey in Tunisia was conducted in 2008.
http://stats.uis.unesco.org/unesco/TableViewer/document.aspx?ReportId=3587&IF_Language=eng&BR_Country=7880&BR_Region=40525

in the last decade. 12.8% of all university graduates have degrees in science and engineering (age 20-29) close to the EU average. The government's ambition is to accelerate the number of scientists and engineers in Tunisia. However, a key issue to address is the quality of education.
In 2010, there were six researchers per 1000 total employment.[8] However, only 10% of the 19600 Full Time Equivalent (FTE) researchers were employed on a full time basis and nearly 900 researchers were employed in private firms. Among those there are 8,000 master degree unsalaried (mostly part time) students. This confirms the dominance of Higher Education in scientific research.

The most important barrier to R&D investment is low technology of Small and Medium Enterprises (SMEs), dominating the economy with limited R&D investments and capabilities (Arvanitis R. and M'henni H. (2010)). However, recent R&D surveys have identified about 100 companies that seem to position themselves in high technology niches. The existing incentives have limited impact on the transfer of research results to the private sector and the creation of new businesses through commercialisation (Koubaa and al. (2008)).

Finally, the lack of private funding for R&D and innovation, venture capital and business angel investments minimise potential research commercialisation. The figures are striking when we examine economic results: less than 5% of Tunisian exports are industrial in high technology sectors (2010) and less than 2% of jobs are created in the high-tech services (2008).

Strengthening the innovation system is necessary if Tunisian firms are to move up the value chain and the technological ladder. Most Tunisian firms are SMEs that have limited capacity to innovate on their own. These firms need a strong and supportive innovation ecosystem. Critical reforms to strengthen Tunisia's innovation ecosystem include (i) adopting a balanced innovation strategy, (ii) enhancing the efficiency and effectiveness of R&D spending, (iii) increasing the supply of adequate skills and competencies and, (iv) strengthening the financing of innovation.

Direct collaboration between researchers in public laboratories/universities and private firms is limited and cumbersome. Three factors play a key role in this poor outcome: (i) limited demand from the private sector due to its predominant specialization in low value-added sectors and sub-contracting; (ii) a mismatch between the nature of public research and the needs of firms and (iii) complex bureaucratic procedures.

Re-enforcing collaboration between universities, public research organisations and industry is one of the most important priorities identified in the National Development Plan. This is shown by the proliferation of relevant measures and the higher level of funds allocated to support collaborative research.

The idea of setting Technoparks could help Tunisia improve its innovation performance by integrating production, research and education in the same place, thus allowing a fast

[8] The number of researchers (FTE and HC) is considered as "overestimated" by UIS. The explanation is that in Tunisia, are also considered as full time researchers all the students of the second year of Master's degree. The Frascati Manual did not exclude this type of counting particularly when the student dedicates all his time to research activity.

diffusion of new technologies and innovation. However, international experiences, as discussed in section 2, shows that TP are complex institutions and success is not always guaranteed.

4. The Technopark program in Tunisia

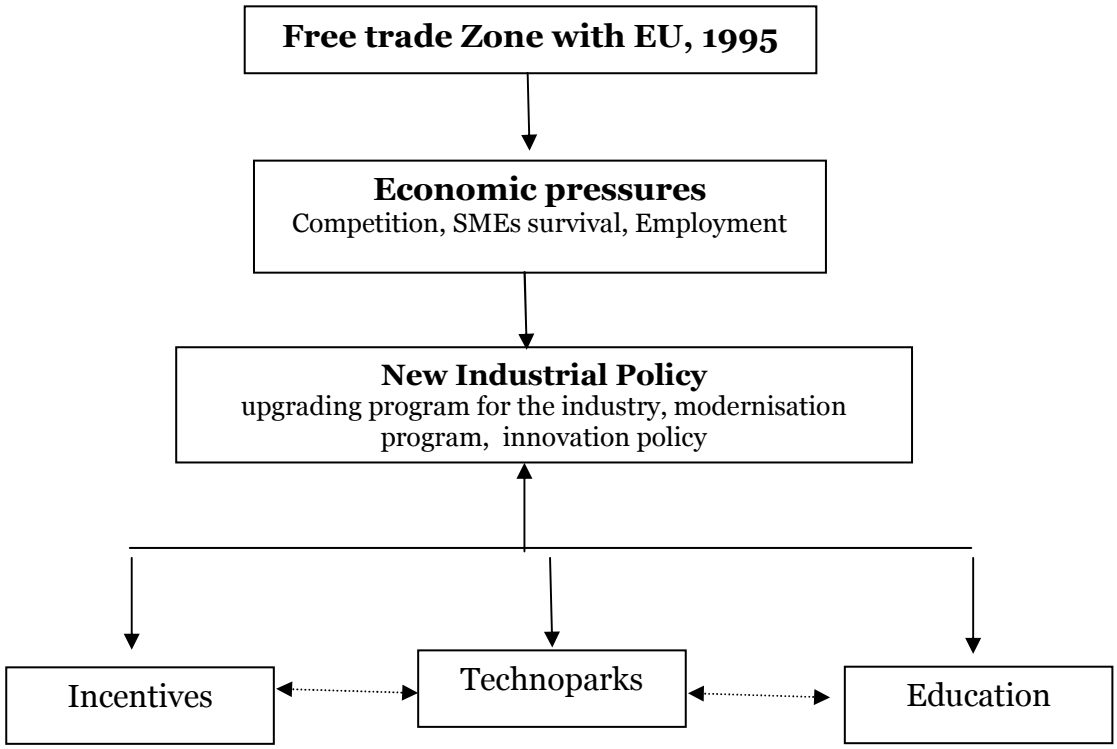
In this section we explain the rationale of the Technopark policy in Tunisia and discuss its performance. While Tunisia has decided to set up nine Technoparks, only one (El Ghazela) seems to fulfil the prerequisites and is performing well.

4.1. The rationale of Technoparks in Tunisia

One of the main challenges facing the Tunisian economy in the next few years is to open its economy to foreign exchange of goods, capital and services, particularly after the signature of an Association Agreements with the EU in 1995 which dismantled tariffs for industrial products in 2008. This process allowed the EU to become the first trading partner of Tunisia, currently accounting for about 75% of Tunisian exports and imports. At the same time, Tunisia is one of EU's best established trading partners in the Mediterranean region, and ranks 30th among EU's trading partners in the World. To be internationally competitive, Tunisia undertook some economic reforms such as modernisation program of Tunisian industries which included physical (tangible) equipment and (non-tangible) incentives mainly dedicated to enhance the human capacities and to innovative activities.

In the mid-1990s, taking advantage of the new telecommunication era and the Internet revolution, the government decided to create the first TP in Tunisia (the first for Africa and the Arab World). The 8th Development Plan detailed for the first time the objective of the programme, its main components and the budget allocated.

The ultimate objective was to create a "park of excellence" or a "specialised excellence park" where researchers, academics, businessmen and senior managers will work closely together to find appropriate solutions for market and societal needs. TPs will serve three essential purposes: (1) provide an impetus for R&D and innovation in the private sector; (2) strengthen links between university (and public) research and the productive sector; and (3) promote regional development.



In the 10th Plan of Development, the idea to create more Technoparks in the most important cities of the country like Sfax, Sousse, Monastir and Bizert became apparent. Gradually, the creation of Technoparks became the largest and the most ambitious Science and Technology (S&T) programever launched in Tunisia. Setting up technoparks and/or business incubators in different administrative regions constitutes a real challenge in a country where the number of highly competitive companies on an international scale is very limited and where researchers and academics do not have the culture of working with businesses (Arvanitis R. and Mhenni H. (2012).

In the official documents of the Ministry of Higher Education and Scientific Research, the Technopark program mainly aimed to:

- Develop high level competencies to manage innovative projects;
- Support scientific research in the fields related to the national priorities and the needs of the global economy;
- Promote technological innovation;
- Support the incubation and the creation of innovating companies through the valorization of research results;
- Promote innovating projects with high added value;
- Polarize economic enterprises whose activities are based on R&D and Technological innovation;
- Stimulate job creation, in particular for higher education graduates;
- Improve the competitive capacity of the Tunisian company;
- Promote public – private partnerships;
- Foster Foreign Direct Investment (FDI);

In 2000, priority areas identified by the Higher Council for Scientific Research and Technology were ICT, Agriculture, Food and Cereals; Biotechnology; Water Resources, Health and Energy. These priorities correspond to specific problems in Tunisia such as the lack of water resources, increasing dependence on oil imports and the vertiginous rise of the food prices in international markets.

On the manufacturing side, textile, agri-foods, mechanics and electronic were the priority as they were the most performing sectors with the highest export levels in the last decade. The Technoparks program supportsthe national thematic priorities:

1. Mechanics and Electronics: Sousse Technopark
2. ICT and Multimedia: El-Gazala and Sfax Technopark
3. Water, Energy, Plant Biotechnology: Borj Cedria Technopark
4. Health, Human and Animal Biotechnology: Sidi Thabet Technopark.
5. Textile: Monastir-El Fejja Technopark
6. Agri-food: Bizerte Technopark
7. Agriculture and forest resssources: Jendouba Technopark
8. Desert ressources: Medenine Technopark
9. Phosphates and other mineral ressources: Gafsa Technopark

The National Development Plan (2007-2011) is a roadmap for building national research infrastructures. Investments allocated for the research sector during the 11th Plan amounted to approx. €360m (TND680m). The tangible research investments are based on the rationale that Tunisia needs to strengthen its existing research base and build capacity in new areas of strategic importance in order to enhance the level of competition of the Tunisian firms in the international markets.

The table below illustrates that nearly 17% of all investments allocated to the research sector during the 11th Plan (2007-2011) were dedicated to the Technoparks program.

Investments (in €m)		Main projects
Investment under the supervision of the Ministry of Higher Education and Scientific Research	140.4	Research organisations
		Federated research programmes
		Technological innovation
		Scientific information
		Competence development
		Infrastructure
		Scientific equipment
		Academic research
Sector-based research programmes	150.5	Agriculture
		Health
		ICT
Technoparks	70,1	Borj Cedria, Sousse, Sfax, Elghazala and new ones
		Development and studies of the parks

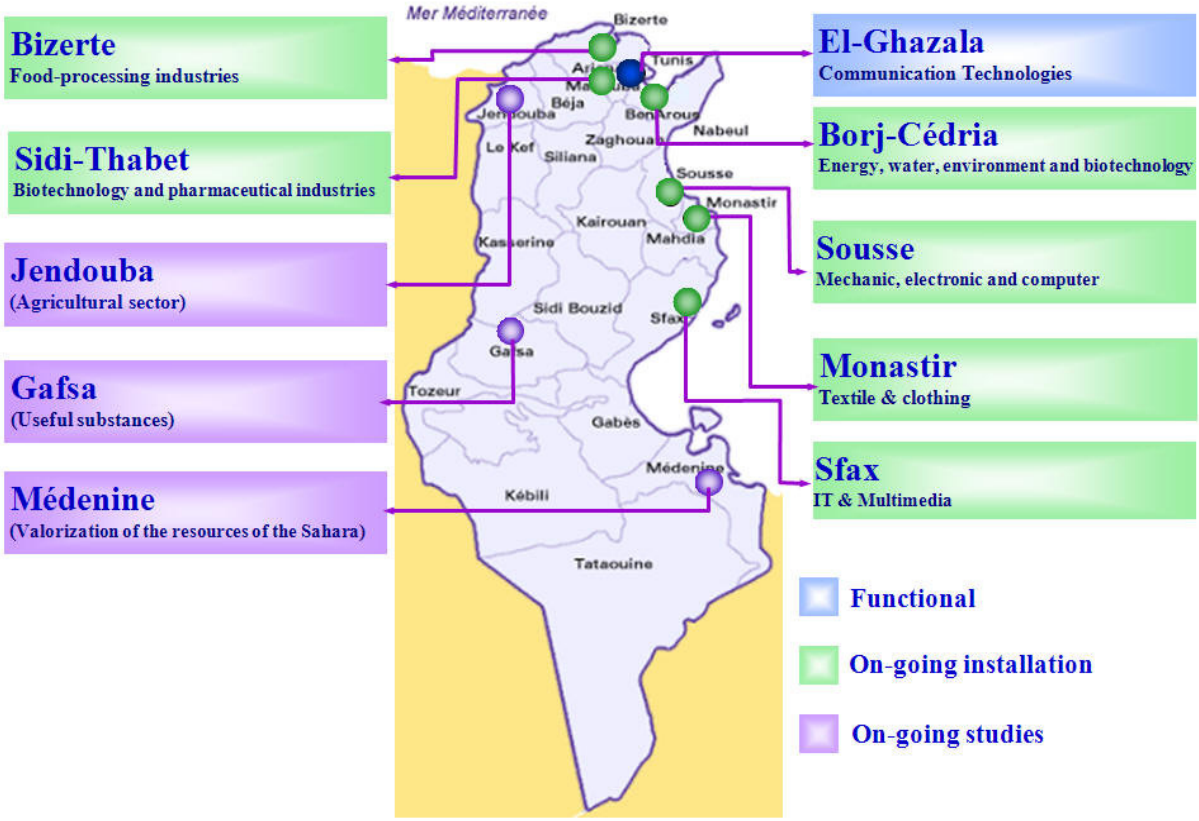
Source: Economic and Social Development in Tunisia (2007-2011): toward a higher stage of Growth. Project Data sheets. Ministry of Development and International Cooperation. Republic of Tunisia

4.2 Achievements of existing Technoparks

Tunisia has been investing in Technoparks since the late 1990s. The objective is to create jobs and foster an innovation dynamics through an integration of research, production and human capital around a specific product/ sector in a specific geographical region.

Through a direct valorization of research, the technoparks could be an important tool for incubation of innovative activities.

In 2012, Tunisia has one operational Technopark (El Ghazala) specialising in ICT and is setting up six new Technoparks. Three other Technoparks are in the phase of preliminary study. The ultimate aim is to establish 10 Technoparks by the year 2016. These Technoparks are spread throughout the country as follows:



Source: Ministry of Higher Education and Scientific Research. www.mes.tn

In August 2007, decisions taken to enhance the governance and the structures of Technoparks led to setting up management and exploitation companies. The participation of banks and other public or private organisations is expected to facilitate the identification of business opportunities and raise awareness among investors. These companies play the role of a single liaison office supplying services to firms willing to be located in the parks (Arvanitis and Mhenni (2012)).

Research infrastructure is associated with the creation/development of research centres. During the 11th planning period, many research centres have been renovated while some new ones were built. This was the case of the four research centres in Borj Cedria Technopark in the areas of water, energy, biotechnology and materials. In the same space a new Center of Technological Resources, a business incubator and a Platform for technological resources were built. In the Technopark of Sousse a Microelectronics and nanotechnology research centre, an incubator and a Technology Resource Centre were built. In Sfax, the construction of the new Centre for Research in multimedia computing and digital data processing is quite advanced.

Since 2001, a programme of business incubators has been implemented in industrial zones or within research centres and universities. Thirty six business incubators were created from 2001 to 2011, but some of them are not totally operational. More than 2000 holders of projects benefited from the services of incubators in 2011 against 518 in 2005. The incubators provide advice and auxiliary services to the project carrier, principally young entrepreneurs and researchers, from preparing a business plan to legal, fiscal and marketing assistance. Higher Education Institutions (HEI) and Public Research Institutions (PRI) incubators where implemented to provide a framework to encourage the creation of spinoffs. The creation of Technoparks in some regions of the country is expected to boost the business incubators' programme and to attract innovative ideas. The programme benefits from the technical and financial support of international entities like UNIDO and the European Investment Bank and from countries through bilateral agreements like France for Bizerte TP and Monastir TP and Japan for Borj Cedria TP.

4.2. Relative success of ICT Technopark (El Ghazela)

By 2011, the Technopark of El Ghazela, specialised in Information and Communication Technologies, housed nearly 90 companies (over three times the number of firms in 2003), and employed about 2,000 staff. 60% of the production of these firms is exported mainly to Europe but increasingly to African countries.

The firm TELNET, a Tunisian success story is a start-up which became a very important industrial Conglomerate in the country expanding its activities over the ICT sector in 10 years. Recently they setup a new airline company called Syphax). The Technopark can be considered as a successful one and is presented as a good example for developing countries. Morocco and Algeria implemented similar technoparks half decade after the Tunisian experience.

Several factors can explain this relative success of the El Ghazala Technopark. First, the park successfully attracted multinationals early on. Microsoft, ST Microelectronics, Ericsson, Alcatel Lucent and seven other leading ICT international companies are present in the park. The Diaspora played a crucial role in attracting the multinationals. In fact, high profile managers working in these companies have convinced their board to go to Tunisia. They took the lead in local management since they knew the Tunisian context. These companies work closely with sub-contractors and manage an informal network. Second, the cooperation between firms is high. They exchange information and share training. This dynamic was also observed by Ben Youssef and Quéré (1999 and 2007) in Sophia-Antipolis (France) which explained its take off.

The Technopark as an institution offering services to local firms and coordinating their actions seems to be efficient. It hosts several annual meeting of the Euro-Med IT Forum, Tunisian IT showroom, and African Events. It works closely with the government in order to attract FDI in this sector. Implementation of the firms in the Park is based on real expertise and potential for NTBF rather than political considerations.

The Technopark hosts two higher education institutions: the Telecommunications School of Tunis and the High Institute of Technical Studies in Telecommunications. Seven research laboratories and units contribute to enhance the R&D activity in the Park. These

institutions work closely with other universities and research centres in Tunis. These exchanges guarantee that the "local labor market" satisfies the needs of these firms. Cooperation between firms and Higher Education Institutions is high. For example, in order to address the shortage of "high profile ICT staff", the firms within the network work closely with the University of Tunis and other Private universities in order to set a special training session responding to their needs.

Another explanation of the take-off of the El Ghazala Technopark is the cultural argument explained by Eto (2005). Tunis, as a big city, offers a setting with cultural facilities. It is thus easy to attract FDI and foreign firms are more able to convince their "foreign staff" to open shop in Tunis. Multinationals were able to implement plants in Tunis and a local labour market is emerging in the ICT sector. This is not the case for other cities in Tunisia and to other sectors.

However, the network is facing a big concern: "brain drain". Even when they are offering high competitive salaries, big European companies are hiring their staff. This situation leads to the incapacity to the network to move upward in the value chain of ICT and to produce more complex services and goods.

4.4. Limits of the Tunisian Policy approach of Technoparks

While the Technoparks seem to fulfil its objectives, the global approach of the Tunisian government to Technoparks poses several problems. Nearly fifteen years after their effective start and as was conceived and executed, there were obvious difficulties with their implementation.

First, the number of Technoparks is probably too high for a small developing country like Tunisia. In the ICT industry all the conditions for the implementation of a Technoparks were satisfied: existing local labor market, high level managers from the diaspora in the leading multinationals, renowned universities in specific sectors). These conditions are not satisfied in other domains (e.g., Biotechnology, Electronics). The five other existing Technoparks have no enterprise working for the moment.

Second, Tunisia did not take into account the evolution of science parks and TPs. New designs are emerging in the world. In particular, the substitution of the concept of TPs with new models such as competence centres and clusters. The first model is designed around academic centres of excellence and they produce the most results (publications and patents) and have more interconnections with industrial partners. The second model focuses on the most successful industrial clusters in the country and supports their efforts by providing research centres, technical resources centres, higher education institutions and incubators. These new models avoid the additional costs associated with the development of large empty spaces exploit the academic and industrial potential of the country. The creation of "ex-nihlo" Technoparks is not successful in all the cases. While it is a success in ICT industries, it is not a good model for other industries.

Third Tunisian TPs failed to attract high profile entrepreneurs and managers. The managers of the TP projects, at least at their starting phase, were selected only based on their academic skills instead of their entrepreneurship skills and ability to mobilize networks of "competencies" and skilled people. Following Javanovic's (1982) seminal

paper, the creation of new firms may be the result of the subjective erroneous evaluation of the founder of his (her) own capabilities. Most businessmen, even, new managers coming from the universities are short-term profit seeking which is in conflict with building a national R&D and innovation system, (more long-term profit perspective).

Fourth, the selection process in establishing the location of technoparks and their area of expertise is questionable. The choices were based on political considerations rather than the knowledge of the sector. For example, another ICT and Multimedia TP was set up in Sfax while El Ghazala is working well. At the same time, Sfax is hosting the best research centres in the country and probably in Africa in Biotechnology. But, the Biotechnology TP was set up in Sidi Thabet where there is,. In the same premises, a recognized nuclear research centre which may develop rapidly, given the international context and planned projects in the field of civilian nuclear energy.

Fifth, there is a serious lack of skills and human resources in several TPs. Researchers are not yet available in quality and numbers in some disciplines, thereby preventing the progress of some projects related to research (e.g. such as cancer or nanotechnology. Since Tunisia does not have the ability and the critical mass to develop a TP in a specialized field it is not efficient use of resources to invest in these fields.

Sixth, the role of the government must be reconsidered. For TPs to be successful the the private sector should be in the driver's seat and government should serve as an enabler, providing a conducive innovation ecosystem. In Tunisia, The government played a facilitating role, especially in promoting adaptation and the diffusion of new technologies. Even in cases where firms were created in government incubators, (e.g., Taiwanese electronics and Chilean salmon), they were privatized as soon as they reached commercial viability. Government then turned its attention to facilitation, coordination, and regulation. Instead of fostering conglomerates, Taiwan's government developed clusters of new firms each time an industry transitioned to independent technological development.

While Tunisia seems to generalize clusters (Technoparks) to many areas and products, international experiences suggest that some prerequisites are necessary for success. For instance, the production process should be broken down into interdependent segments, the product must be easily transportable, and the location of the Technopark should be endowed with a dense population of skilled entrepreneurs operating in a favourable investment climate.

5. Concluding Remarks

The objective of this article was to discuss the relevance and efficiency of TPs in Tunisia to contribute to the debate on setting up TPs in emerging countries.
Setting up ten TPs in a small developing country like Tunisia was quite unrealistic. A better strategy would have been to concentrate on three or four specific centres of excellence such as performing universities or industrial zones, leverage the diaspora more effectively, and match the location of the TP with the cities' area of expertise. While TPs are attractive both politically and among development professionals working in the area of science, technology innovation, young entrepreneurs, scientists and researchers

they might not produce the desired outcomes if the necessary prerequisites are not in place.

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